MACHINERY.

February, 1907.

FLOORPLATE PRACTICE IN THE SCHENECTADY SHOPS OF THE GENERAL ELECTRIC COMPANY.

THE use of the portable tool and the floorplate in heavy machine work is such a simple and logical solution of the problem of machining large masses of metal, that it is difficult to realize that a few years ago the system was unknown; the traveling crane even, which has made the system possible, has come into general use in larger sizes within the past two decades only. It is idle to speculate as to what we would have done without the floorplate, the portable tool and the traveling crane, because they are so obviously useful that they were bound to be discovered and put to work as soon as conditions required them. If one man or set of men had not stumbled on the idea, another man or set of men would most assuredly have done so. As is well known, much of the credit for the early development of the system is due to the management of the Schenectady works of the General Electric Co., particularly to Mr. John Riddell, the general superintendent of the plant. In 1901 Mr. Riddell presented a paper on the subject to the American Society of Mechanical Engineers, describing the progress of the system up to that time. Since then the range of this work has been greatly increased in these shops. New buildings and floorplates have been built, new portable machinery has been designed. The photographs reproduced in the accompanying halftones will serve to give some idea of the extent and variety of the operations being performed at the present time by this method.

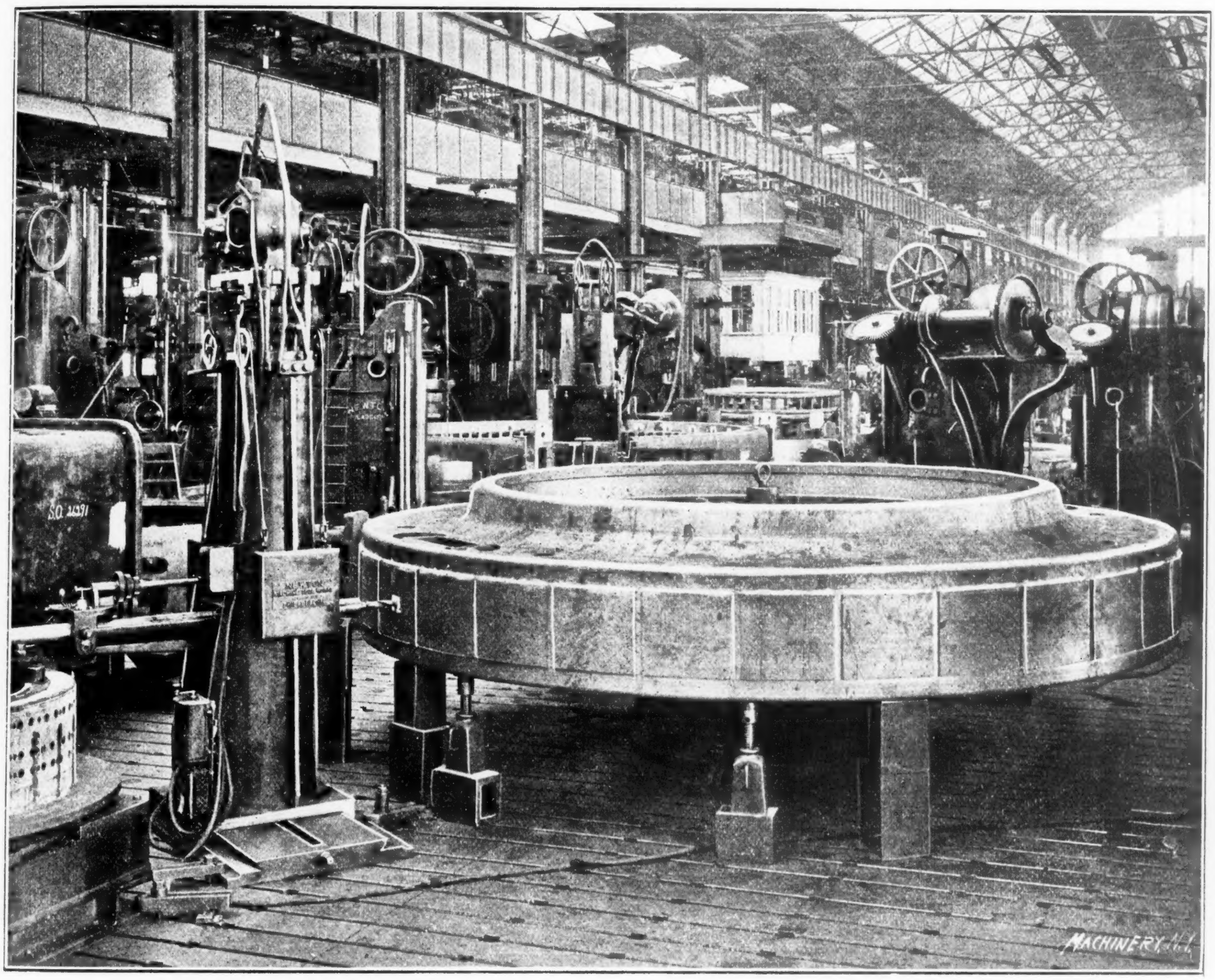


Fig. 1. Portable Drilling and Milling Machine Operating on a Heavy Rotor, in Conjunction with a Portable Central Pivot for Indexing.

In Fig. 2 is shown an example of a machine which is not portable but which is used with the floorplate, although this latter is little more than an incident, merely taking the place of what would otherwise have been the platen or clamping surface of the rotary planer shown. The use of the floorplate, however, simplifies the design of the machine, does away with the necessity for extra foundations other than those already laid for the plate, and gives the advantage of a clamping surface of practically unlimited dimensions. The fact that the work is not fastened in the machine itself but to a base separate from it, seems to have the effect of making the operator realize that after all only a small part of the heavy casting is being worked at a time, and that other surfaces are in position to be machined. As a consequence of this condition it is possible to have operations of various kinds carried on simultaneously on a large piece of work. For instance, the writer in a recent visit to these shops noticed the rotor of a large generator which was having a number of bolt holes drilled in its face by a horizontal milling and drilling machine. This machine, like the planer, happened to be a stationary tool whose bed was formed by the main floorplate of the shop. On the other side of the work was a portable milling and drilling machine performing the corresponding operation there. It perhaps would not have occurred to the foreman to have used the portable tool if the milling and

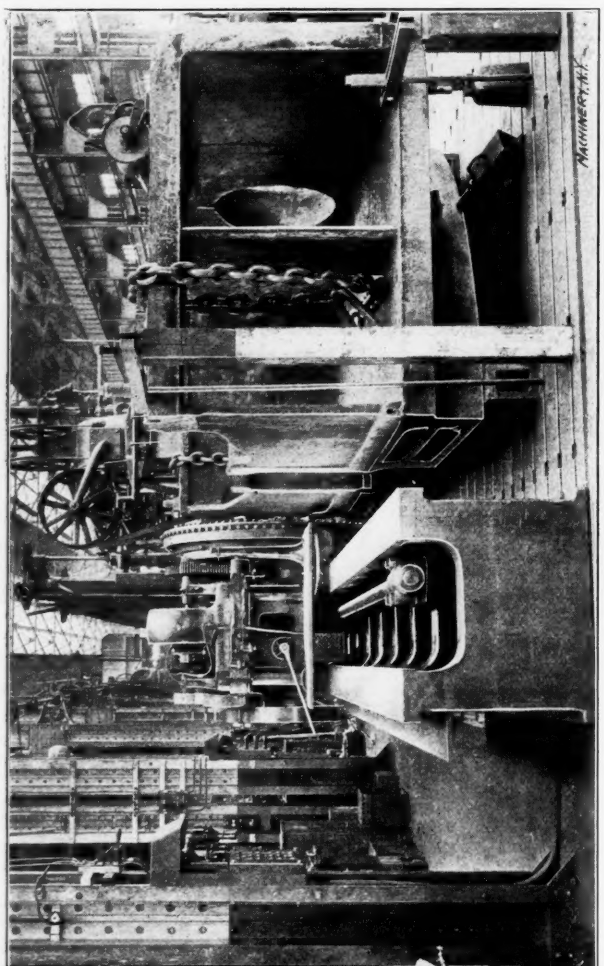


Fig. 2. Rotary Planer with Motor Mounted on the Carriage, Surfacing the Joint on a Heavy Turbine Casting.

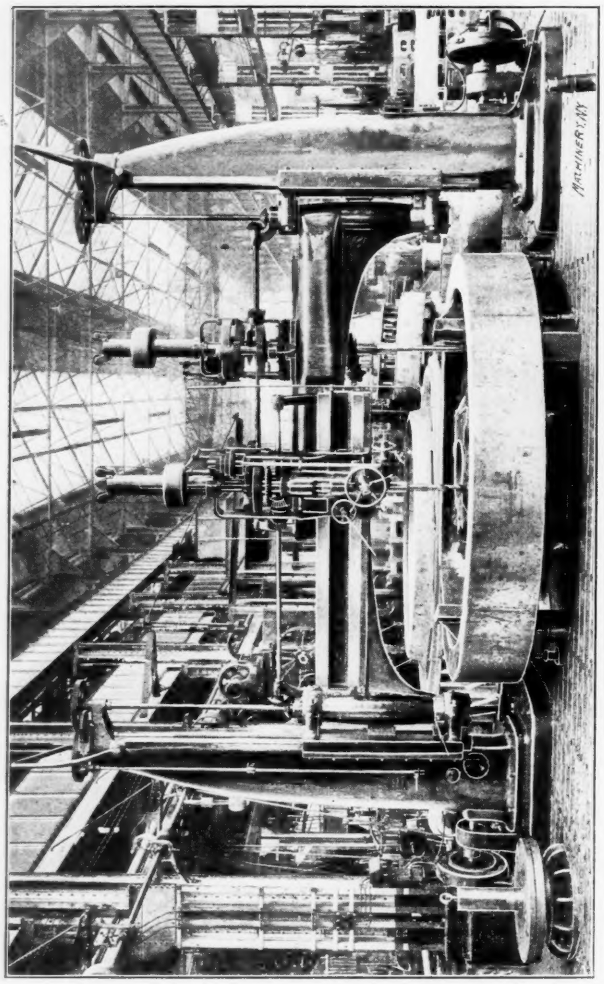


Fig. 3. Two Portable 12-foot Radial Drills at Work Simultaneously on a Revolving Field Spider.

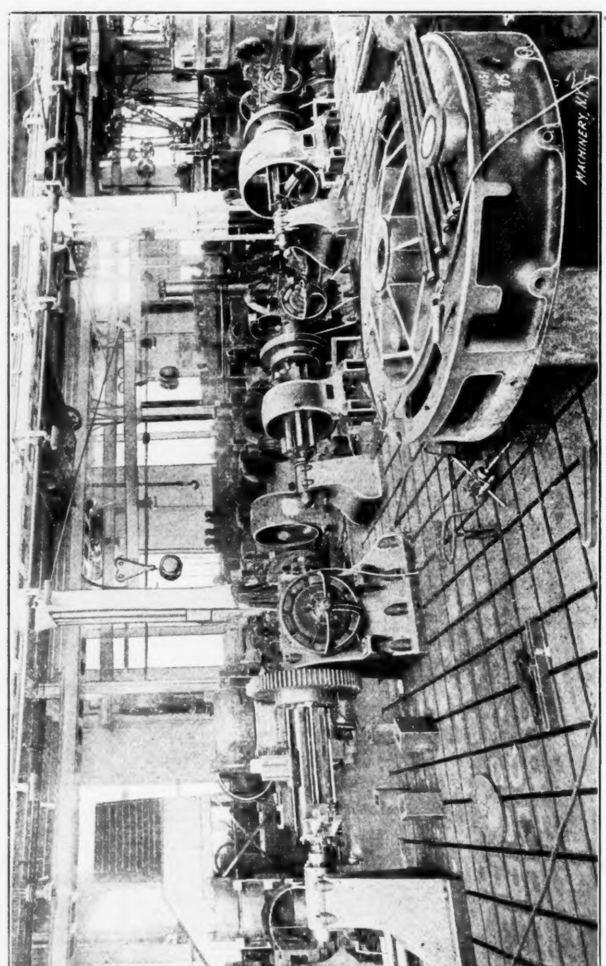


Fig. 4. Boring Headstocks and Tailstocks, used with the Floorplate as a Foundation and Work Clamping Platen.

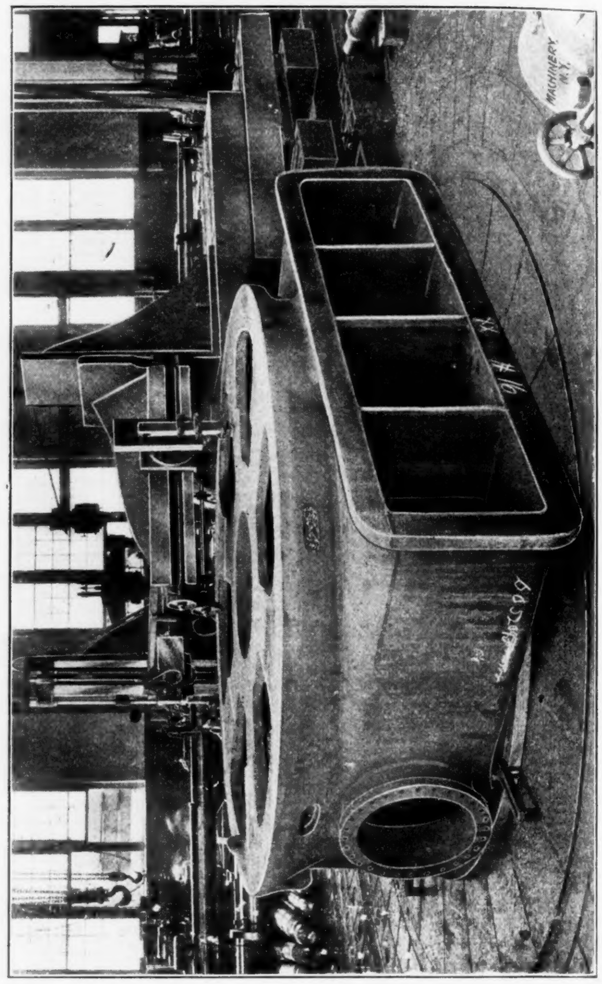


Fig. 5. The Largest Boring Mill in the World at Work; the Regular Heavy Housing is not in use, since this Turbine Exhaust Base is a Comparatively Small Casting.

drilling machine had been a separate tool with a platen of its own. Our readers will remember the grinding device used to sharpen the cutters of the rotary planer, described in the April, 1906, issue of MACHINERY. This attachment is used on the cutter head without removing it from the machine, while the spindle is revolving slowly past the cutters.

In Fig. 3 is shown another example of a machine not greatly altered by the requirements of floorplate practice. Like the rotary planer and the milling and drilling machine just mentioned, these radial drills have merely had their work tables amputated, leaving only base enough to firmly clamp them to the floor. It would have been entirely possible to have drilled the bolt holes in the casting shown, in a radial drill of the ordinary type, but it would have been a purely fortuitous circumstance to have found two machines so placed that they could work together on this casting as are the machines shown in the cut. In fact, except for this particular job, it would have been a nuisance to have had the two drills so close together. The neatness and compactness of the electric drive for conditions of this kind is well shown in the cut. It goes without saying that the portable tool problem would be a serious one if it were not for the direct connected motor.

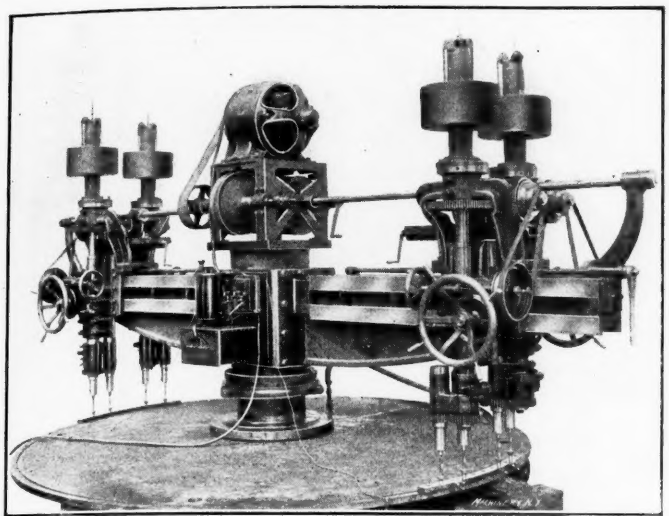


Fig. 6. Special Double-head Radial Drill Driven by 10 H P. Motor Working on a Turbine Disk.

In connection with the horizontal boring, drilling and milling machine shown in Fig. 1, another interesting development of the portable tool is shown. The heavy rotor which is being machined is supported on a portable pivot in the center, which thus furnishes a means for revolving the work and bringing one face after another in proper position to be drilled. The work is steadied by jacks while the drilling is in progress. A similar device is shown in Fig. 8 where a casting is mounted on a portable horizontal dividing head, indexed by the crank shown at the base. The milling and drilling machine here shown is a heavier tool than the one in Fig. 1, and has a considerably greater travel on its base. The motor also, instead of being mounted at the top of the column, is carried by the saddle. Another portable accessory device which the writer noticed in operation, was an electrically-driven pump with suitable piping, pans, etc., which was employed to furnish a supply of cooling water for a horizontal drilling machine, engaged in deep hole work in a steel casting. This arrangement could be moved around from machine to machine as circumstances required.

A highly specialized form of drilling machine is shown in Fig. 6. To a central post (which is clamped to the center of the turbine disk being drilled) is pivoted a sleeve carrying a pair of opposite radial arms; each of these arms carries a double head with two spindles; each of the spindles drives two drills which are adjustable for distance from each other and from the center. Thus eight holes may be drilled for each angular position of the machine. The whole is driven through a variable speed device by a motor mounted on top of the column.

The boring machines shown in Fig. 4 bear the same relation to the floorplate that the rotary planer in Fig. 2 does. That is to say, the machine is simplified to its essential elements of a headstock and a tailstock, with a connecting boring bar. The floorplate merely furnishes the base for the work clamping platen.

Two types of slotters (or "vertical shapers," as they might more properly be called) are used. In Fig. 7 are shown a pair of the worm and rack driven variety working on the opposite ends of two heavy generator bases. It will be noted that one of these machines is made right-handed while the other is left-handed. This, in the case shown, brings the operating side of both machines on the same side of the work, making it unnecessary for the workman to do as much traveling as he would otherwise have to. This idea of building some tools right-hand and others left-hand has been carried out in other machines as well; the two screw-driven slotters shown in Fig. 10 will be seen to follow the same arrangement. This type of slotter is adapted for longer cuts than is the other, although the work shown is almost diminutive as compared with the general run of floorplate work. In both Figs. 9 and 10 it will be noted that the reversing movement for the tool slide is effected by a pair of magnetic clutches mounted on the countershaft to which the driving motor is geared. Extensive use of electric clutches is made in these portable tools and a design has been found which gives very satisfactory results. The best view of the clutches and controlling mechanism of the rack and worm-driven slotter is shown in Fig. 9.

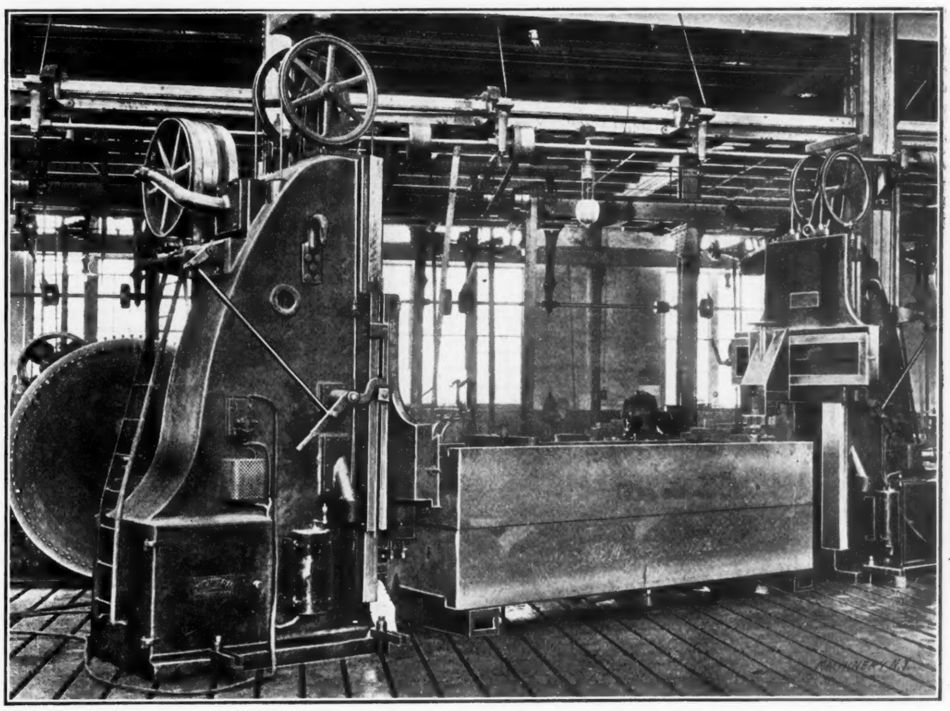


Fig. 7. Two Worm-and-rack Driven Slotters at Work on the Opposite Ends of the same Casting; note that one Machine is Right-handed and the other Left.

A draw-cut shaper is shown in Fig. 11. This tool is much used for horizontal and vertical surfacing, and on account of the slenderness of its ram it will reach into otherwise inaccessible positions. The "draw-cut" principle, however, makes it a rigid tool in spite of the design of the ram; it is put in tension only, being subjected to comparatively little bending

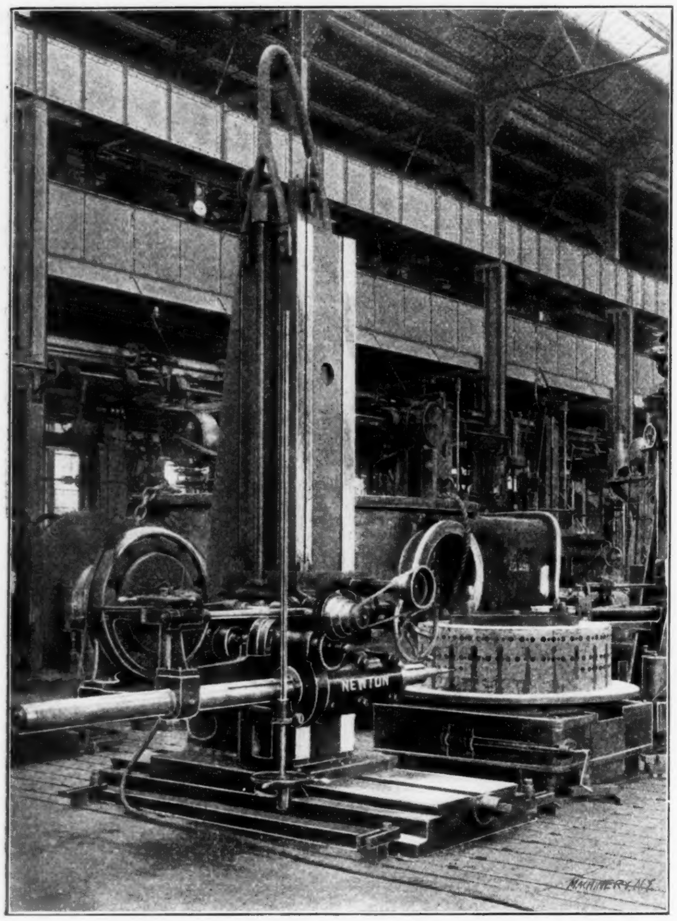


Fig. 8. Portable Horizontal Drilling and Milling Machine, Used in Connection with Portable Indexing Device.

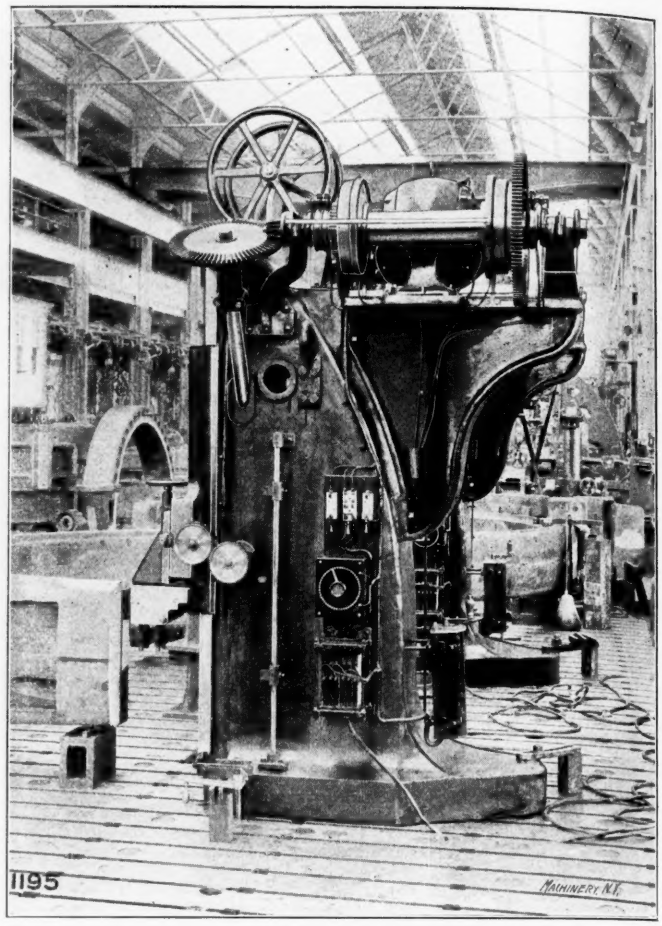


Fig. 9. Side View of Worm-and-rack Driven Slotter, showing Motor Drive and Magnetic Clutches.

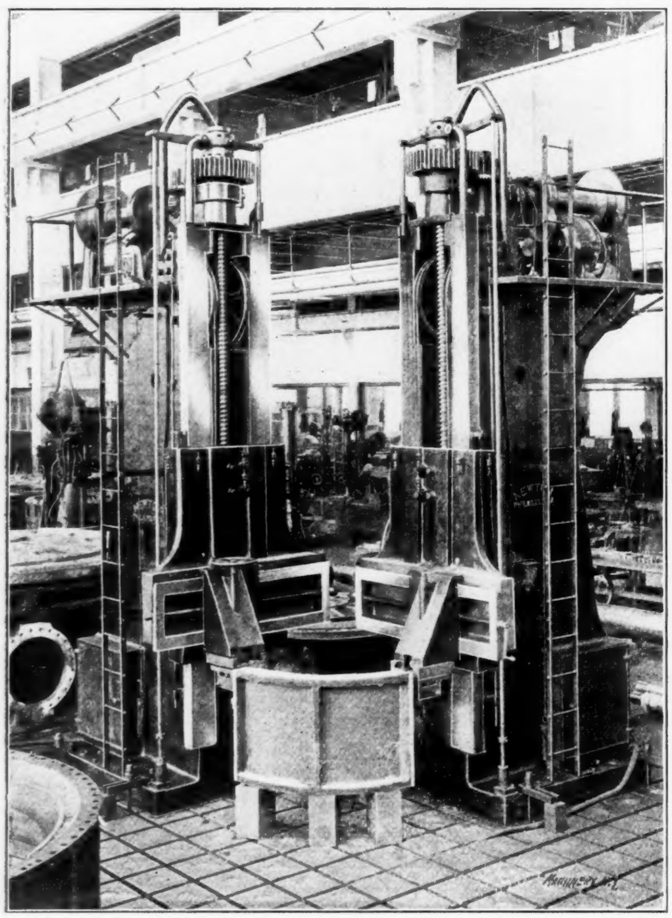


Fig. 10. Two Long Stroke Screw-driven Slotters Working at Right Angles on the Same Piece. The Floorplate here shown is that detailed in Fig. 12.

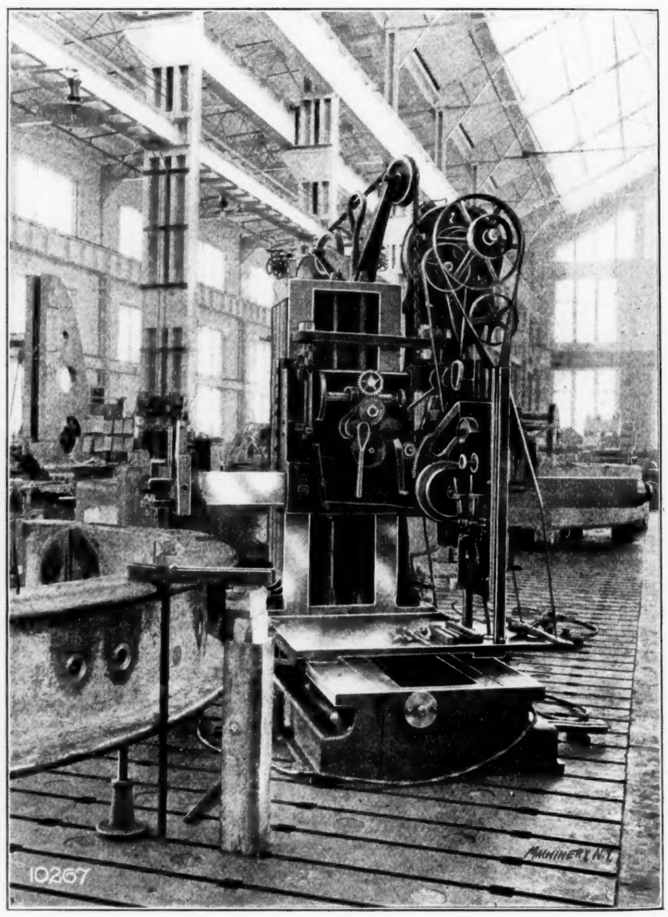


Fig. 11. Draw-cut Shaper; may be Used for Surfacing either Vertical or Horizontal Surfaces.

strain. The whole tendency of the cutting action is to draw the joints of the machine together and thus bring them into the alignment originally intended for them. This cut also gives an excellent idea of the lightness and airiness of the standard type of building in this plant.

In Fig. 5 is shown the 60-foot boring mill at work. This

was illustrated and described in the July, 1903, issue of MACHINERY. The revolving table and the tool slide shown have been built and in use for some time, and have done their work in a very satisfactory manner. The construction of half of the proposed housing is nearing completion, and this will soon be in condition for use. It is not believed at this time that it will be necessary to finish the other half of the housing and cross rail. When the writer saw this machine in operation it was turning the outside of a casting which was probably about 3 feet greater in diameter than the table, or about 23 feet in diameter. The rest of the stationary clamping surface with which the machine is provided was being used for storage and for portable tool work on other castings.

A detailed drawing of one of the most recent floorplates is shown in Fig. 12. Each section is 10 feet square, 8 inches thick, and weighs about 13,700 pounds. The under side is hollowed out to form a series of square pockets with circular openings through to the upper surface. After the plates have been laid on the concrete foundation prepared for them and lined up, fluid cement is poured into these openings. This serves to grout the plate to the foundation, supporting it firmly throughout its entire area and maintaining its original alignment. Cast T-slots cross the plate in each direction at a distance of 15 inches apart. The edges of the plate are finished where each joins to its neighbor, and keyways are cut in the abutting surface in which keys are located to preserve proper relation between two adjoining plates. Adjacent sections are held to each other by bolts and nuts inserted through the pockets shown at the corners; the pockets having the lengthened openings provide for the withdrawal of the bolts, while the narrower ones are used for the placing and tightening of the nuts. This form of plate has been found to be so satisfactory that the design will be used for all future extensions of the system. It is shown in Figs. 4 and 10, while the other cuts show earlier forms.

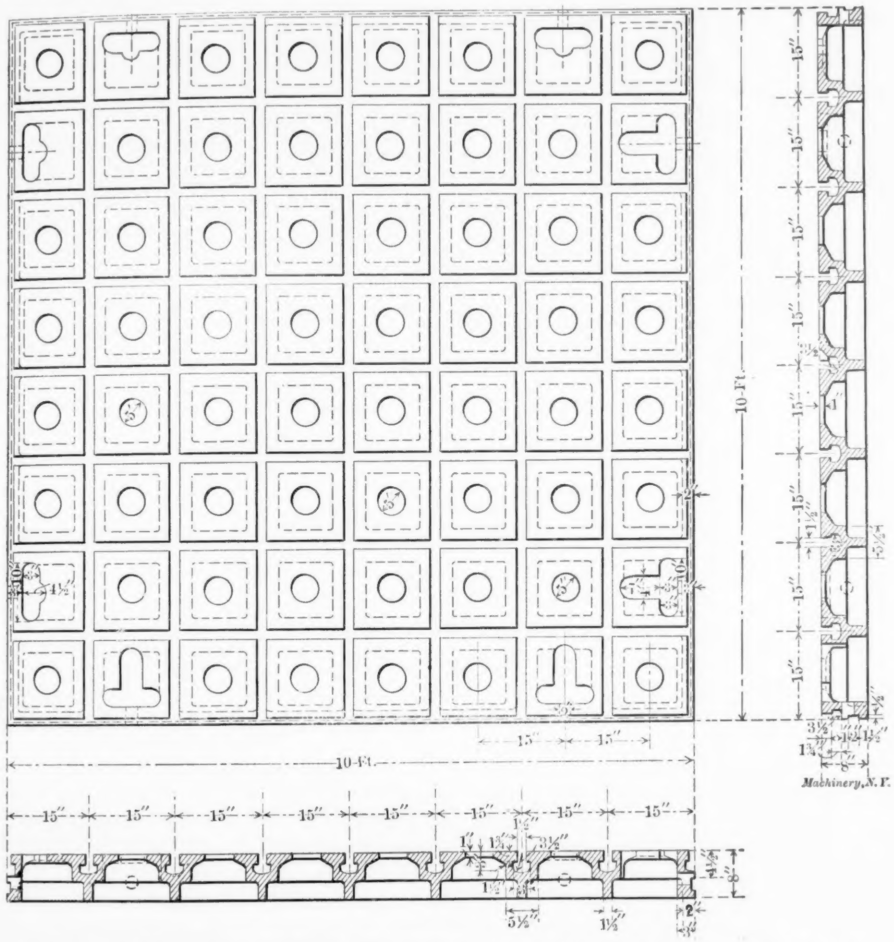


Fig. 12. Detail Drawing of the Floorplate Section used by the General Electric Company in their New Buildings.

* * *

The exposition for Safety Devices which we have previously referred to, was opened in New York January 29, and will be continued for two weeks.

THE DESIGN OF BEARINGS.—3.

CALCULATING THE DIMENSIONS.

FORREST E. CARDULLO.

The durability of the lubricating film is affected in great measure by the character of the load that the bearing carries. When the load is unvarying in amount and direction, as in the case of a shaft carrying a heavy bandwheel, the film is easily ruptured. In those cases where the pressure is variable in amount and direction, as in railway journals and crankpins, the film is much more durable. When the journal only rotates through a small arc, as with the wristpin of a steam engine, the circumstances are most favorable. It has been found that when all other circumstances are exactly similar, a car journal, where the force varies continually in amount and direction, will stand about twice the unit pressure that a flywheel journal will, where the load is steady in amount and direction. A crankpin, since the load completely reverses every revolution, will stand three times, and a wrist-pin, where the load only reverses, but does not make a complete revolution, will stand four times the unit pressure that the flywheel journal will.

The amount of pressure that commercial oils will endure at low speeds without breaking down varies from 500 to 1,000 pounds per square inch, where the load is steady. It is not safe, however, to load a bearing to this extent, since it is only under favorable circumstances that the film will stand this pressure without rupturing. On this account, journal bearings should not be required to stand more than two-thirds of this pressure at slow speeds, and the pressure should be reduced when the speed increases. The approximate unit pressure which a bearing will endure without seizing, is as follows:

$$p = \frac{PK}{DN + K}, \qquad (5)$$

where p is the allowable pressure in pounds per square inch of projected area, D is the diameter of the bearing in inches, N is the number of revolutions of the journal per minute, and P and K depend upon the kind of oil, manner of lubrication, and so on.

The quantity P is the maximum safe unit pressure for the given circumstances, at a very slow speed. In ordinary cases the value of this number will be 200 for collar thrust bearings, 400 for shaft bearings, 800 for car journals, 1,200 for crankpins, and 1,600 for wristpins. In exceptional circumstances, these values may be increased by as much as 50 per cent, but only when the workmanship is of the best, the care the most skillful, the bearing readily accessible, and the oil of the best quality, and unusually viscous. It is only in the case of very large machinery, which will have the most expert supervision, that such values can be safely adopted. In the case of the great units built for the Subway power plant in New York by the Allis-Chalmers Co. the value of P in the formula given above, for the crankpins, was 2,000—as high a value as it is ever safe to use.

The factor K depends upon the method of oiling, the rapidity of cooling, and the care which the journal is likely to get. It will be found to have about the following values: Ordinary work, drop-feed lubrication, 700; first-class care, drop-feed lubrication, 1,000; force-feed lubrication or ring-oiling, 1,200 to 1,500; extreme limit for perfect lubrication and air-cooled bearings 2,000. The value 2,000 is seldom used, except in locomotive work where the rapid circulation of the air

cools the journals. Higher values than this may only be used in the case of water-cooled bearings.

The above formula is in convenient form for work with journals. In case the bearing is some form of a sliding shoe, the quantity 240 V should be substituted for the quantity $D\,N$ in the equation, V being the velocity of rubbing in feet per second. There are a few cases where a unit pressure sufficient to break down the oil film is allowable. Such cases are the pins of punching and shearing machines, pivots of swing bridges, and so on. The motion is so slow that heating cannot well result, and the effects of scoring cannot be serious. Sometimes bearing pressures up to the safe working stress of the material are used, but better practice is to use pressures not in excess of 4,000 pounds per square inch.

In general, the diameter of a shaft or pin is fixed from considerations of strength or stiffness. Having obtained the proper diameter, we must next make the bearing long enough so that the unit pressure shall not exceed the required value. This length may be found directly by means of the equation:

$$L = \frac{W}{P\,K}\left(N + \frac{K}{D}\right) \qquad (6)$$

where L is the length of the bearing in inches, W the load upon it in pounds, and P, K, N and D are as before.

A bearing may give poor satisfaction because it is too long, as well as because it is too short. Almost every bearing is in the condition of a loaded beam, and therefore it has some deflection. Let us take the case of an overhung crankpin, in

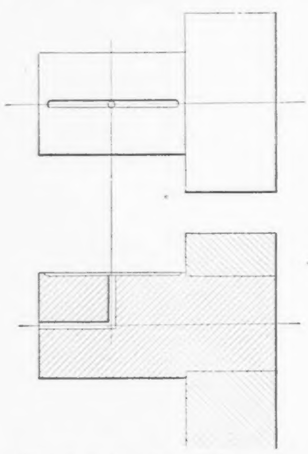
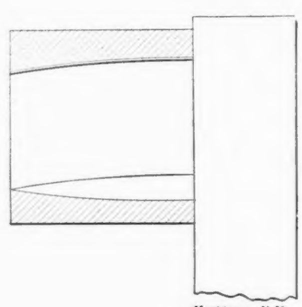


Fig. 5. Internally-oiled Crankpin, showing Oil Passages and Grooves.



Machinery, N.Y.

Fig. 6. Section showing the Bending of a Crankpin and Consequent Unequal Wear of the Box.

order to examine the phenomena occurring in a bearing under these circumstances. When the engine is first run, both the pin and box are, or should be, truly round and cylindrical. As the pin deflects under the action of the load, the pressure becomes greater on the side toward the crank throw, breaking down the oil film at that point, and causing heating. After a while the box becomes worn to a slightly larger diameter at the side toward the crank, in the manner shown in Fig. 6, which is a section showing in an exaggerated manner the condition of affairs in the box and pin, when under load.

It has already been noted that the box must be a trifle larger in diameter than the journal, and for successful working this difference is very strictly defined, and can vary only within narrow limits. Should the pin be too large, the oil film will be too thin, and easily ruptured. On the other hand, should the pin be too small the bearing surface becomes concentrated at a line, and the greater unit pressure at that point ruptures the film. This is exactly what happens when the pin is too long. The box rapidly wears large at the inner end, and the pressure becomes concentrated along a line as a consequence. The lubricating film then breaks down, and the pin heats and scores. The remedy is not to make the pin longer, so as to reduce the unit pressure, but to decrease its length and to increase its diameter, causing the pressure to be evenly distributed over the entire bearing surface.

The same principles apply to the design of shafts and center crankpins. They must not be made so long that they will allow the load to concentrate at any point. A very good rule for the length of a journal is to make the ratio of the length to the diameter about equal to one-eighth of the square root of the number of revolutions per minute. This quantity may be diminished by from 10 to 20 per cent in the case of crankpins and increased in the same proportion in the case of shaft bearings, but it is not wise to depart too far from it. In the case of an engine making 100 revolutions per minute, the bearings would be by this rule from one and a quarter to one and a half diameters in length. In the case of a motor running at 1,000 revolutions per minute, the bearings would be about four diameters long. While the above is not a hard and fast rule which must be adhered to on all occasions, it will be found to be an excellent guide in all cases of doubt.

The diameter of a shaft or pin must be such that it will be strong and stiff enough to do its work properly. In order to design it for strength and stiffness, it is first necessary to know its length. This may be assumed from the following equation:

$$L = \frac{20\,W\sqrt{N}}{P\,K}, \qquad (7)$$

where all the quantities are the same as in the preceding equations. Having found the approximate length by the use of the above equation, the diameter of the shaft or pin may be found by any of the standard equations given in the different works on machine design. It is next in order to recompute the length from formula No. 6, taking this new value if it does not differ materially from the one first assumed. If it does, and especially if it is greater than the assumed length, take the mean value of the assumed and computed lengths, and try again.

A few examples will serve to make plain the methods of designing bearings by means of these principles. Let us take as the first case the collar thrust bearings on a 10-inch propeller shaft, running at 150 revolutions per minute, and with a thrust of 60,000 pounds. Assuming that the thrust rings will be 2 inches wide, their mean diameter will be 12 inches. From equation No. 5 we will have for the allowable bearing pressure $\frac{200 \times 700}{12 \times 150 + 700}$, or 56 pounds per square inch. This will require a bearing of 60,000 ÷ 56, or 1,070 square inches area. Since each ring has an area of 0.7854 $(14^2 - 10^2)$, or about 75 square inches, the number of rings needed will be 1,070 ÷ 75, or 14. In case it was desirable to keep down the size of this bearing, the constant K might have had values as high as 1,000 instead of 700.

Next, we will take the main bearing of a horizontal engine. We will assume that the diameter of the shaft is 15 inches, that the weight of the shaft, flywheel, crankpin, one-half the connecting rod, and any other moving parts that may be supported by the bearings, is 120,000 pounds, and that two-thirds of this weight comes on the main bearing, the remainder coming on the outboard bearing. The engine runs at 100 revolutions per minute. In this case, $W = 80{,}000$ pounds, $P = 400$ pounds per square inch, and K depends on the care and method of lubrication. Assuming that the bearing will be flushed with oil by some gravity system, and that, since the engine is large the care will be excellent, we will take $K = 1{,}500$. This gives us for the length of the bearing from formula No. 6:

$$L = \frac{80{,}000}{400 \times 1{,}500}\left(100 + \frac{1{,}500}{15}\right) = 26\tfrac{1}{2} \text{ inches (about).}$$

It is to be noted that, in computing the length of this bearing, the pressure of the steam on the piston does not enter in, since it is not a steady pressure, like the weight of the moving parts. The only matter to be noted in connection with the steam load is that the projected area of the main bearing of an engine shall be in excess of the projected area of the crankpin.

For another example we will take the case of the bearings of a 100,000-pound hopper car, weighing 40,000, and with eight 33-inch wheels. The journals are $5\tfrac{1}{2}$ inches diameter, and the car is to run at 30 miles per hour. The wheels will make 307 revolutions per minute when running at this speed, and the load on each journal will be 140,000 ÷ 8, or 17,500 pounds.

Although the journal will be well lubricated by means of an oil pad, it will receive but indifferent care, so the value of K will be taken as 1,200. The length of the journal will then be

$$L = \frac{17{,}500}{800 \times 1{,}200} \left(307 + \frac{1{,}200}{5.5}\right) = 9\tfrac{3}{4} \text{ inches (about).}$$

As a last example, we will take the case of the crankpin of an engine with a 20-inch steam cylinder, running at 80 revolutions per minute, and having a maximum unbalanced steam pressure of 100 pounds per square inch. The maximum, and not the mean steam pressure should be taken in the case of crank and wristpins. The total steam load on the piston is 31,400 pounds. P will be taken as 1,200, and K as 1,000. We will therefore obtain for our trial length:

$$L = \frac{20 \times 31{,}400 \times \sqrt{80}}{1{,}200 \times 1{,}000} = 4.7, \text{ or, say, } 4\tfrac{3}{4} \text{ inches.}$$

In order that the deflection of the pin shall not be sufficient to destroy the lubricating film we have

$$D = 0.09 \sqrt[4]{W L^3}$$

which limits the deflection to 0.003 inch. Substituting in this equation, we have for the diameter 3.85 or say $3\frac{7}{8}$ inches. With this diameter we will obtain the length of the bearing, by using formula No. 6, and find

$$L = \frac{31{,}400}{1{,}200 \times 1{,}000} \left(80 + \frac{1{,}000}{3\frac{7}{8}}\right) = 8.9, \text{ say 9 inches.}$$

The mean of this value, and the one obtained before is about 7 inches. Substituting this in the equation for the diameter, we get $5\frac{1}{4}$ inches. Substituting this new diameter in equation No. 6 we have

$$L = \frac{31{,}400}{1{,}200 \times 1{,}000} \left(80 + \frac{1{,}000}{5\frac{1}{4}}\right) = 7.05, \text{ say 7 inches.}$$

Probably most good designers would prefer to take about half an inch off the length of this pin, and add it to the diameter, making it $5\frac{3}{4} \times 6\frac{1}{2}$ inches, and this will be found to bring the ratio of the length to the diameter nearer to one-eighth of the square root of the number of revolutions.

* * *

Some years ago the United States Navy converted an old cruiser into a floating workshop, equipping it in such a manner as to be fitted for attending to the execution of repairs necessary for a fleet at sea. The practical value of a vessel of the Vulcan type was demonstrated during the war with Spain. In England they have at the present time gone a step further in that they have built a new vessel which is to be equipped in such a way that when completed it will practically be a naval machine shop; it will have a fully equipped foundry with cupolas where damaged parts of machinery can be replaced by new castings, a boiler shop with shearing and punching machines, just as in a shipyard, carpenter shop, blacksmith shop, and regular machine shop. Besides this there will be special departments for electricians. The vessel will also be provided with a large ice-making plant and a set of gigantic condensers capable, if need be, of supplying a fleet with fresh water.

* * *

The pure food law which went into effect January 1 promises to work a much needed reformation in the manufacture of food products. The adulteration and substitution practiced by unscrupulous manufacturers are almost beyond belief, and being skilfully done their counterfeit goods all but put out of business concerns having more business honor. Now the consumer will know what he buys if he will but read the labels. See what a cheap "flavor of vanilla" is composed of: "Pure proof spirits 30.60 per cent; water and sugar 69.26 per cent; synthetic vanillin and synthetic coumarin, a trace; colored with caramel. Enough of it might give one a "jag," but there is not a trace of extract of the vanilla bean in a car-load for even the pitiful amount of "vanillin" is made chemically by oxidizing a crystalline extract of pine pitch.

STRENGTH OF PUNCH AND SHEAR FRAMES.

FRANK B. KLEINHANS.

The vital part of a punching or shearing machine is the housing or frame. If this gives way the rest of the machinery is liable to become broken. If one of these castings break, it costs almost as much to replace it, as it would to buy a new machine. It is, therefore, important that we know how much metal to put in the housing in order to perform certain work.

We will assume that we have a punch frame like that shown in Fig. 1. The depth of the throat is to be 8 inches and the machine is to be capable of punching a ¾-inch hole in ¾-inch boiler plate. The effort or force which would be necessary to push this punch through the plate with a flat punch would be obtained as follows: Take the ultimate shearing stress at 60,000 per square inch; we then have:

$$P = \frac{3 \times 3 \times \pi \times 60{,}000}{4 \times 4} = 106{,}000 \text{ lbs.}$$

In order to obtain the proper section of frame, a preliminary section is assumed and from this the final section is calculated. If the stress is too high or too low, the section is in-

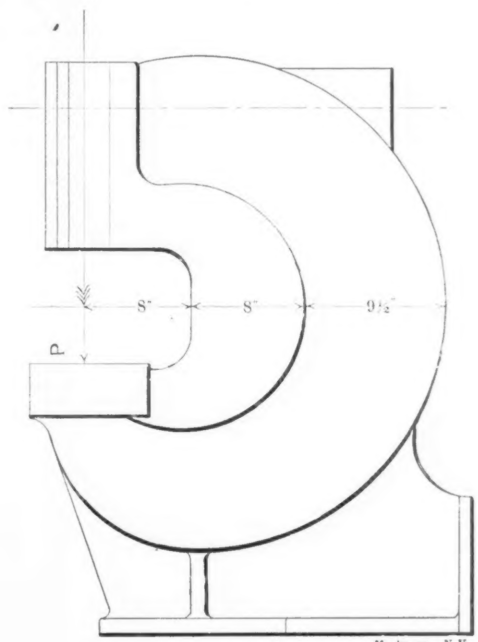


Fig. 1. Sketch of Frame for 3-4 inch Punch.

creased or decreased as circumstances may require. For the case in question the section is assumed to be that shown in Fig. 2. P-P is the center line of the punch; L is the distance from the center line to the line C-C passing through the center of gravity of the section. We will proceed to determine the stress set up in this section under these conditions.

Divide the section into parallel strips as indicated in the figure. Place a row of dimensions giving the width of each strip as shown. From the center of gravity of each one of these sections, drop the perpendicular lines 1, 2, 3, etc. Mark each one of these lines with a figure as indicated. Next determine the area of each one of these sections. Place the area opposite the number of the section in the form of a table, as shown in Fig. 2, and obtain the sum of the areas of all the strips. This is the area of the section and will be designated by A_1.

Draw a line 0-8 in any convenient location parallel to the perpendicular lines 1, 2, 3, etc. On this line with any convenient scale lay off 0-1 which is to represent the area of the first strip. Then lay off a distance 1-2, whose length is to the length of 0-1 as the area of the second strip is to the area of the first, and so on, drawing 2-3, 3-4, etc., to 8. Line 0-8 will then represent the total area A_1. Draw $0\,x$ and $8\,x$ at angles of 45 degrees with 0-8, draw rays from x to 1, 2, 3, etc. From any point O in the perpendicular line from the first strip of the section, draw $O\,C$ parallel to $x\,0$. Draw a line $O\,H$ parallel to $x\,1$. Draw a line $H\,K$ parallel to $x\,2$. Continue the process and finally draw the line $P\,C$ parallel to $x\,8$. If the figure

is well drawn, intersection C will take place in the vertical line drawn through the center of gravity of the section. The area of this figure is obtained by drawing a horizontal line $Y\ Z$, so located as to make the area added to the triangle equal to the area cut away. This can readily be done by looking through the transparent triangle and comparing one area with the other; we can now readily obtain the area of this triangle from measurement. We find that the length of

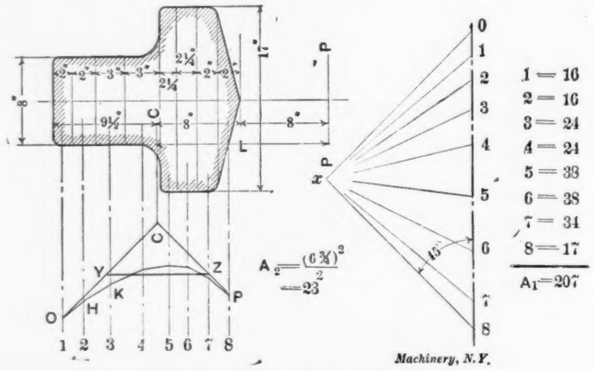


Fig. 2. Diagram for Finding Strength of Frame.

one side is 6¾ units. Let A_2 equal the area of this triangle, we then have, since the triangle is half of a square,

$$A_2 = \frac{(6\tfrac{3}{4})^2}{2} = 23.$$

If the section has been drawn full size, this result will be 23 square inches.

Knowing the area of the section A_1 and the area of this triangle A_2 the moment of inertia of the section can be obtained by multiplying these two areas together.

Let I = moment of inertia of the section, then
Let $I = A_1 \times A_2 = 207 \times 23 = 4{,}761$.
Let $L = 16$
Let $P = 106{,}000$ as found above.
Let C_t = Distance from center of gravity to extreme fiber on the tension side.
Let C_c = Distance from center of gravity to extreme fiber on compression side.
Let S_t = Stress in tension produced by the load P.
Let S_c = Stress on compression produced by the load P.

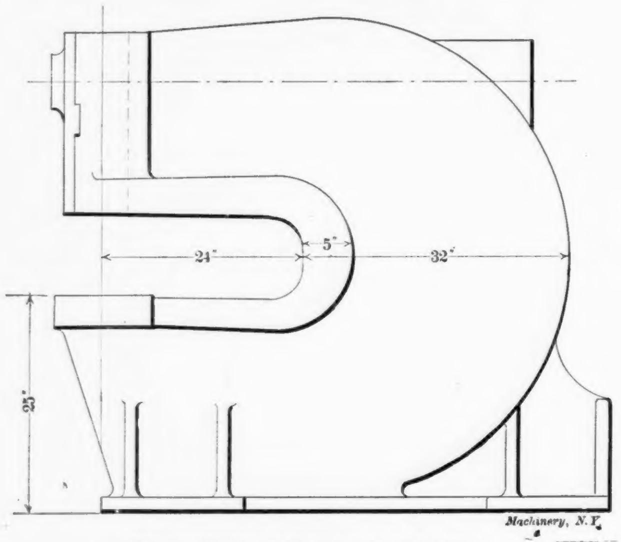


Fig. 3. Sketch of Frame for 1-inch Punch.

$$S_t = \frac{P}{A_1} + \frac{PLC_t}{I}$$

$$S_c = \frac{P}{A_1} - \frac{PLC_c}{I}$$

$$S_t = 512 + \frac{106{,}000 \times 16 \times 8}{4{,}761}$$

$$= 512 + 2850 = 3362 \text{ lbs. per sq. inch.}$$

$$S_c = 512 - \frac{106{,}000 \times 16 \times 19}{23 \times 207 \times 2}$$

$$512 - 3385 = -2873 \text{ lbs. per sq. inch.}$$

Fig. 3 shows a punch or shear housing with a somewhat deeper throat. This machine has the capacity to punch 1 inch diameter in 1-inch stock.

$P = 1 \times 1 \times \pi \times 60{,}000 = 188{,}000.$
$L = 34$, as shown in Fig. 4.

$$S_t = \frac{P}{A_1} + \frac{PLC_t}{I}$$

I is obtained from the section Fig. 4. Divide the section into convenient areas and drop the perpendicular from the center of gravity as shown. Complete the construction, after which we find,

$A_1 = 197 \qquad C_t = 10$
$A_2 = 112 \qquad C_c = 22$

$$I = A_1 \times A_2 = 22{,}000.$$

Introducing these values in the above equation we have

$$S_t = \frac{188{,}000}{197} + \frac{188{,}000 \times 34 \times 10}{112 \times 197}$$

$$= 950 + 2900 = 3850.$$

The stress in tension for cast iron for work like punching and shearing should not exceed 4,000 lbs. per sq. inch. As

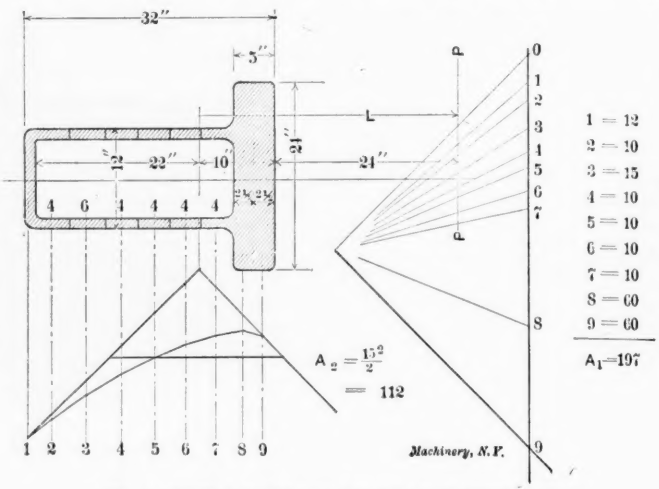


Fig. 4. Finding the Stresses in the 1-inch Punch Frame.

the tension in either one of the above cases is less than this amount, the sections will be considered safe.

$$S_c = 950 - \frac{188{,}000 \times 34 \times 22}{112 \times 197} = -5420.$$

The stress in compression may run up to 10,000 lbs. per square inch, either one of the above sections is seen to be amply safe in compression. If the first section tried does not meet requirements, the problem simply resolves itself into a matter of altering it until it is sufficiently strong.

* * *

Edward Pergoli and James Flood of New York were recently found guilty and fined $100 each for "stealing trade secrets" and the action of the lower court has been sustained by the Court of Special Sessions. The action is based on the anti-tipping law passed by the New York Legislature in 1906 which prohibits any gift or gratuity being given to an employe with the intent of influencing his action in a manner detrimental to his employer's business. It seems that Flood, the superintendent of a tobacco concern, with Pergoli persuaded a young man named Durand to secure a job in a tin-foil factory for the purpose of discovering secrets of manufacture, and disclosing them to Flood and Pergoli.

* * *

The Crystal City plant of the Pittsburg Plate Glass Company is now about completed at Crystal City, Mo., 28 miles below St. Louis. There are 15 buildings, all of reinforced concrete. It is estimated that 50,000 barrels of cement will be used in the building process. Even the roofs are to be reinforced concrete tile, 4 feet by 8 feet.

THE MANUFACTURE OF SHOT-GUNS AT THE ITHACA GUN COMPANY'S WORKS.

W. L. McLAREN.

The accompanying halftones show some views taken recently in the works of the Ithaca Gun Co., Ithaca, N. Y., and will serve to help in conveying an idea of this branch of manufacture as it impressed the writer. The Ithaca Gun Co. was established in 1880 and incorporated in 1904. The business was started by Messrs. L. A. Smith and George Livermore, and is entirely devoted to the manufacture of double-barreled shot-guns of different sizes and grades. No cheap guns are manufactured, but only high-grade fire-arms, many of which are highly ornamented and finished, and priced as high as $300.

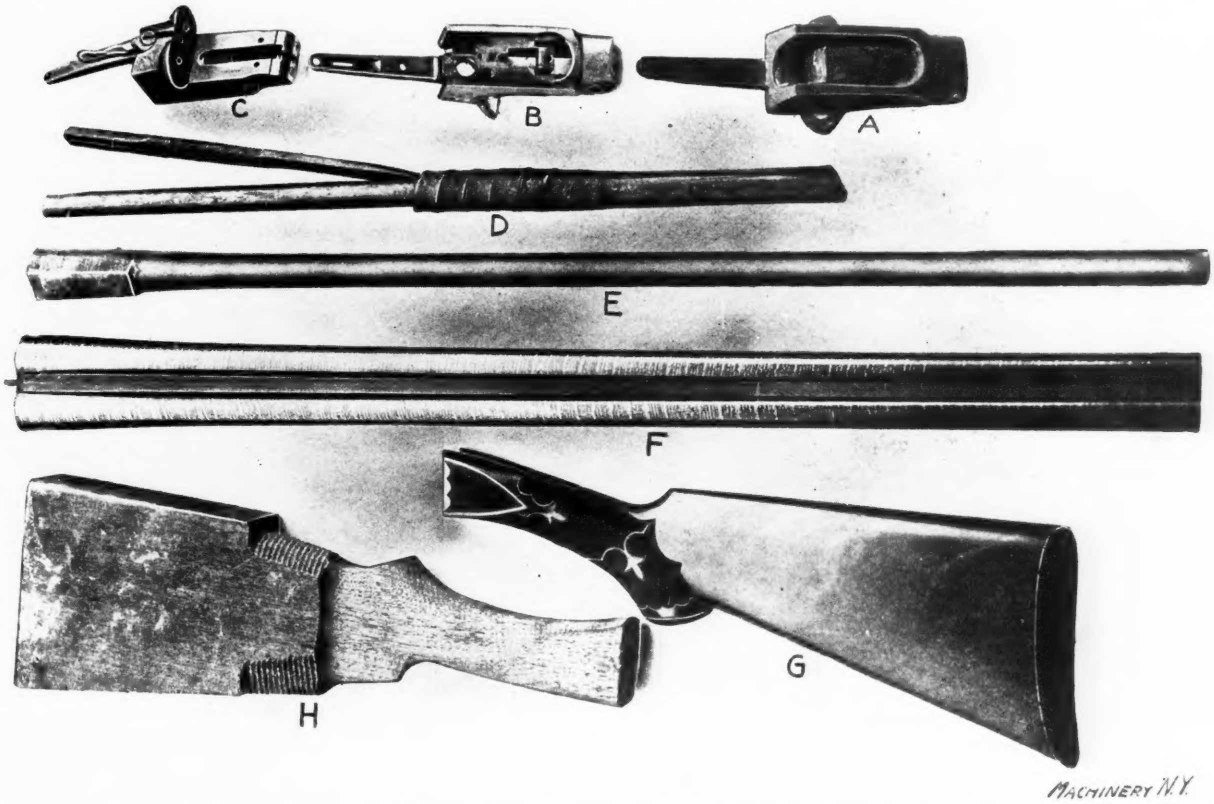
The barrels are all imported; they come in boxes containing 50 pairs of barrels each, rough-turned and rough-bored to within 0.030 inch of finished size. The lower-priced guns are fitted with the famous Cockerill steel plain black barrel; then, next in price comes the laminated twist steel barrels; then in order are barrels of Damascus steel, following which in quality come the Krupp-Essen fluid steel barrels with their stamped trademark showing a little soldier holding a gun; the last and highest grade in price are the guns with Whitworth fluid steel barrels, these barrels all being numbered and accompanied by a certificate. In case of breakage or failure through a flaw "it is up to the manufacturer" to replace them.

The first operation on a pair of shot-gun barrels is to turn them to size, and then to chamber the breech for the cartridge shell. It requires at least five operations to remove the 0.030 inch stock left by the barrel makers. After being bored to size the barrels are hand polished with emery and the opposite sides of a pair of barrels are milled for the lug which is brazed in. The steel rib joining the barrels is then brazed in and the assembled barrels are mounted in the milling machine and the rib milled concave. The next operation is "matting" the rib, which is done on a special machine, the top surface of the rib being knurled or matted with a single revolving tool mounted on the end of a spindle controlled by a cam. The cam causes the tool to raise and lower every half revolution to conform to the concave surface of the rib. The table is fed one mat cut for each revolution of the tool, producing much the same effect as a knurling tool would on circular work. This machine is one of many special machines designed and made by the company for the manufacture of shot-guns.

After going through various milling operations on the lug, the barrels are polished and sent to the finishing room where they are rusted with chemicals from five to six days, according to weather conditions. This rusting brings out the figure or pattern of the barrels; the iron blackens while the steel shows white, producing the well-known twist and Damascus effect. The fluid steel barrels of course show no such variations of color and are finished to a dead black.

The frames are received in the shape of rough drop forgings and are mostly machined by milling operations. One interesting operation on the frames is that of forming the "ball," as it is called, on each side of the frame. The table of the milling machine is fed longitudinally until the work reaches the point where the ball is to be machined. Here a trip is thrown which engages the circular feed of an auxiliary table and an instant later another trip is sprung, throwing out the first feed. Of course the reason for throwing one feed in before letting out the other is to avoid leaving a mark on the surface, which would surely follow the stopping of the first feed before throwing in the circular feed. The frame now revolves through a half circle while the cutter mills both the flat and the curved surfaces. Various shaped cutters, according to the style of the frame, are used, the principle of the cutters being a combination of a plain and corner-rounding cutter. The ball formed is in reality a quarter of an ellipsoid. The diameter, measured vertically as the gun is held in shooting position, is about as 5 is to 4 to the diameter in the other direction. To get this curve requires some careful calculation and setting, and there are four of these special milling machines for this particular operation.

There is a slot in the lower side of the gun frame where the lug of the barrel fits when the gun is closed and locked. For years this slot had been machined by milling and broaching, until very recently a Hendey-Norton oscillating milling machine, as shown in Fig. 4, was installed for this work. This machine does the job in quick time and very accurately. The cutter is mounted on the end of a U-shaped arm attached to a spindle which oscillates. The center of the cutter is coincident with the extension of the spindle axis. Various sized cutters are used, of course, for various sized slots; the teeth have no clearance and cut in both directions. The holes for the slots are drilled first, the same as formerly. The slot



A.—Rough-forged Frame. B.—Milled Frame. C.—Finished Frame. D.—Barrel under Construction, showing Belgian Method of Forging. E.—Imported Rough Tube for Barrel. F.—Pair of Finished Barrels. G—Finished Stock. H.—Stock Partially Turned.

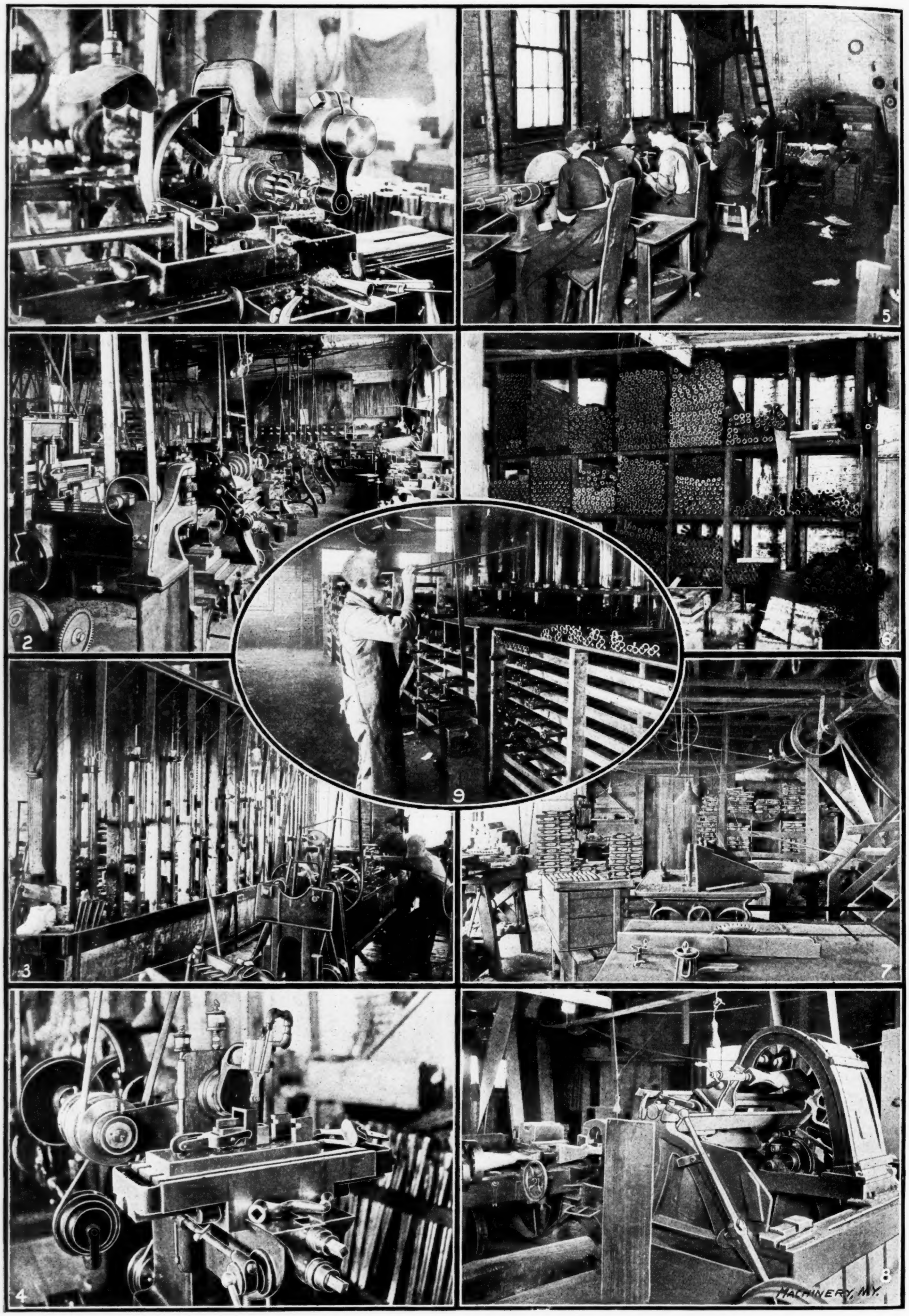


Fig. 1. Taking Straddle Cut on Lug in Milling Machine.
Fig. 2. Toolroom.
Fig. 3. Upright Gun-barrel Boring Machine (to the left).
Fig. 4. Oscillating Miller.
Fig. 5. Polishing Room.
Fig. 6. Barrel Stock-room.
Fig. 7. Stock and Fore-end Forming Department.
Fig. 8. Stock-turning Machines; to the left is the Rough-turning Machine and to the right the Finishing Machine.
Fig. 9. "Bob" Edwards, Veteran Barrel Borer, straightening Tubes before Brazing together.

that is worked out by this operation is plainly shown at *C*, in the first cut, it being the rectangular slot in the center of the machined frame. The work is mounted on the table and fed up while the cutter oscillates back and forth, removing the metal with each forward and backward stroke. In this manner it is possible to machine by an operation analogous to milling those parts which an ordinary milling cutter could not reach. (For a description of the Hendey-Norton oscillating miller see MACHINERY, April, 1905.)

The smaller parts of the guns such as triggers, guards, and lock mechanisms, are either drop forged or punched from steel stock; all parts are made from the best grade of steel obtainable. Each piece, except the smallest parts of a lock, is numbered and this system of numbering extends to the wooden stock and fore-end. The frames are not casehardened until after being fitted to the stocks. The casehardening process requires 2½ to 3 hours heating in the fire and is done in a pack of bone and charcoal. It requires an experienced man to produce the beautiful effects so noticeable on the casehardened parts of guns. The trigger guards are blued chemically.

The stocks and fore-ends are made of black walnut, the wood being mostly imported. They are rough turned on a rough turning gun-stock turning lathe, and are then passed on to another machine which completes the operation, both these machines, of course, being essentially of the Blanchard type of turning lathe. Next the stocks go to the inlaying machine which carves out the recesses for the inset metal parts to fit in. At *H* is shown a stock partly turned, and at *G* is one finished so far as machining is concerned, the rest of the finishing work before done by hand with sandpaper, etc.

The shop is driven by a 21-inch Morgan & Smith waterwheel working under a 39-foot head at 390 R. P. M. At this speed and head the wheel develops about 105 horsepower. A steam plant is also provided to run the works if necessary during low water periods, but it is seldom called into service. During the busy season in the fall and winter the plant runs night and day, the average production being about 80 shotguns a day.

While being shown through the works I was introduced to Mr. Bob Edwards, foreman of the barrel boring department, who is, I am informed, the oldest gun borer in the United States. Fig. 9 shows him in the characteristic attitude of examining a barrel and indicates the simple, not to say primitive, equipment with which the delicate work of straightening a barrel is done.

Mr. Patch, the superintendent, who has been with the company over twenty-three years, informed me that there are over 100 separate milling machine operations on each gun and these operations of course do not include the many drilling, reaming and other operations.

* * *

Plumbers' solder, or wiping solder as it is commonly called, is composed of 40 per cent tin and 60 per cent lead. It has the interesting and valuable feature that at certain temperatures it takes the form of a pliable mass, allowing it to be easily handled and molded to produce the characteristic form of plumber's wiped joint. This operation of wiping is briefly described by the *Valve World* as follows: "The parts to be joined are first freshly tinned at the points of contact, to remove the oxide, and then firmly placed and secured in position. The melted solder is poured on the parts for the purpose of heating them. As the parts become hot the solder becomes cool, taking on the pliable form above mentioned, and is easily manipulated by the mats in the hands of the mechanic, when the joining is completed." It might be added that the ability to make a wiped joint is the principal stock in trade of the average plumber as distinguished from a steam fitter, and that no good reason for maintaining this ancient method of making plumbing connections exists in general. There are a number of mechanical joints on the market which have the merit of cheapness, ease of application, and which can be readily disconnected in case of needed repairs. Needless to say, the plumbing fraternity have worked tooth and nail against the general adoption of this needful improvement, which is bound to come sooner or later, nevertheless.

A MID-WINTER PICNIC AT SANDY HOOK.

R. E. F.

When secretary and president-to-be Hutton, at the Wednesday morning session of the A. S. M. E., finished his explanation of the pleasure and instruction to be derived from the trip to Sandy Hook, I was so much impressed that I immediately made my way to the desk on the floor below where the tickets were sold, and bought one. I was pleased to discover, after some questioning, that the ticket was good not only for the railroad journey but for lunch as well—going at least, and perhaps on the way back also. The day before the event, Thursday, was very nasty, and it had begun to look as though the party for the proposed trip would be a small one, but Friday morning dawned bright and clear with nothing more disagreeable in sight than a 40-knot breeze and a temperature hovering around zero, so a majority of the members changed their minds about staying in town and hastened to the ferry station instead, where a great many tickets were sold. Some of them took their wives and other female relatives with them, despite the warning Prof. Hutton had given that it was likely to be a disagreeable trip for them.

There were ten cars in our train when it left the station of the Central Railroad of New Jersey at Jersey City, and they were all just about full. Probably there were 600 of us, more or less. The train was like most excursion trains, rather hesitating in its movements, and not given to making up its mind very rapidly. It hesitated some time before it worked up courage to cross the draw in Newark Bay, and had a still longer period of indecision before the combined efforts of the train force and the earnest prayers of the excursionists, gave it courage to cross the Raritan at Perth Amboy. During this state of indecision, we were out on an open causeway with no obstructions of any size between us and the North Pole whence the wind was coming. Some people in our car had friends in the next, and some people in the next car had friends in ours, so we were never in any doubt as to what the weather was outside. It must be said, however, that this deliberation of movement had the advantage of giving us all a very clear and vivid impression of the geographical features and industrial development of western New Jersey.

Enter—The Caterer.

It was about this time, an hour or so from the time the train started, that the caterer began to show signs of life. We had been wondering for some little time how he was going to handle us all, but he evidently knew his business. The front car appeared to be his storehouse. At intervals of two or three minutes a procession of waiters would pass along the aisle, some of them carrying large packages of square pasteboard boxes, and others with things in their hands that looked like watering pots with the sprinklers removed. From such of these pots as had their spouts turned in my direction it was possible to detect an odor which at once detracted one's attention from the landscape outside of the window. Two bundles of boxes and two watering pots were deposited at the rear end of each car, and then the distribution commenced. Each member of the party was given a box about 6½ inches square and a little glass of drinkable—either red or yellow, according to his principles. The caterer displayed very good judgment in deciding on the contents of these little boxes; each contained a napkin, a dried beef sandwich, a chicken sandwich, two hard boiled eggs, a little package of salt and pepper, a small cake, a big red apple, and a pickle. After one box had been emptied it was entirely possible to get another. After this we arrived at Sandy Hook.

Special Courtesies to Foreigners.

When the train stopped at the entrance to the government reservation out on the bleak and windy sea coast, a number of the military officers of the place were there to welcome us. Here again we stayed several minutes, during which time our interest was diverted by the passage through each car of a member of the party deputed to inquire of each if, on his word of honor, he would be willing to admit that he was an American citizen. Every one in our car seemed to be guilty,

but apparently this was not the case throughout the train, for a few minutes later an officer, accompanied by a soldier with a megaphone, made his way down through the aisle with a train of attending foreigners behind him. As he entered each car he announced: "Will all members of the party in this car not citizens of the United States please attach themselves to the party which I am to lead? Special courtesies will be shown them." After the excitement caused by this incident had had plenty of time to die away, the train started up again and we made our way toward the north end of Sandy Hook, where the proving grounds and the fortifications of Fort Hancock are located.

An Interview with a Big Gun.

First the train was backed up on a long Y-track to the place where was set up the great 16-inch gun recently built for coast defence service. Here Brigadier-General Crozier, Chief of Ordnance, met us and, as we assembled on the platform around the breech of the big gun, made a little address of welcome, giving a brief description of the manufacture and capabilities of this immense piece of ordnance. After a lot of figures as to weights, muzzle velocities, powder pressures, etc., which slip out of one's mind as rapidly as they are given, he told us that the gun had been built to see whether we could do it or not. He was happy to be able to tell us that the experiment had been a complete success in every particular; that the various laws relating to gun design and construction which had proven true in the case of small sizes had also held good in this, and that all the calculations had been found correct. He told us that so far as any present vessels of possible enemies are concerned, 12-inch guns are big enough, so for the present no more of the 16-inch size are to be built. It is a pleasure and a satisfaction to know, however, that we can build them if we want to.

The gun is a monster. Some of the party climbed up on top of it and went out to the overhanging end. Two or three other inquisitive ones piled a couple of boxes on an empty barrel and climbed to the top for a view into the throat of the creature, at imminent risk of having their shins barked for their pains. A crank was applied and the breech was opened and closed for our benefit. The movements involved in this motion are very interesting. The process is a continuous one. First, a worm meshing in worm-wheel teeth in the breech block gives it a partial rotation to unlock it; the worm is not only a worm in one direction, but is a spur gear as well in the other; as soon as it has ceased to act on the worm wheel, it takes hold of a rack on the side of the breech block and backs it out of the chamber. On reaching the extremity of its movement in this direction, the continued movement of the handle through the action of the connecting bevel gear between the crankshaft and the worm wheel shaft, swings the block and its carrier around to one side, leaving the chamber open and unobstructed for the projectile and the charge of powder. The gun is set up on a temporary foundation in the sand, just rugged enough for the purpose of trial firing.

From here we plowed our way through the sand and dense undergrowth of scraggly, thorny shrubs to the shore, where a couple of targets were set up, one of them being a section of the armor of the Iowa, the other of the battleship Tennessee. These are to be fired on by guns further up the beach to determine the effect produced under varying conditions. We then returned again from the beach to the train, and were taken back to the main line and started for the proving grounds, but not until President Taylor, President-elect Hutton, and Generals Crozier and Murray had had their pictures taken at the breech of the 16-inch gun.

The Proving Grounds.

At the proving grounds we again debarked. Here were all sorts and sizes of rifles, mortars, field guns, rapid-firing guns, etc. These are mounted on concrete platforms with concrete buttresses or bulwarks behind them, presumably provided so that if anything bursts, the fragments will hit the mass of concrete and not go beyond it. Back of these is a high tower of steel with a large room on top from which the firing is directed and observations taken. We passed along the platforms from gun to gun, examining the mechanism, looking into muzzles and working various handles and levers, and then we were all grouped on the concrete structure in back and the firing commenced. A 6-inch rapid-fire gun, throwing a cast-iron shell, was twice discharged. There was nothing very depressing about the report from this gun, and the nervous members of the party began to feel reassured. Next came five rounds from a 15-pound gun fired in remarkably fast time. Two or three other reports were heard from different parts of the platform and then, at a signal from the officer in charge, a 10-inch rifle on a disappearing carriage arose from its bed as lightly and gracefully as a feather, without shock or sound of any kind. After a little delay due to the arranging of the electrical connections of the speed indicating mechanism, the order was given to fire, and we stuck our fingers in our ears and gritted our teeth. A dull, heavy report followed and the gun was down in its bed again. Several seconds after, I neglected to take my watch out so I do not know just how long, out toward the east somewhere a white cloud of spray shot into the air to a considerable height, and a great flock of gulls which had been floating on the water arose, filling the air with the flash of light from their wings. Their excitement could be very plainly seen through the glasses.

Gun Maneuvering and Sub-caliber Practice.

From here we made our way to Fort Hancock, whose batteries we were to inspect. Brigadier-General Murray, Chief of Staff of the United States Army, led the procession and explained the guns and fortifications as we went along. From the front there is little to be seen that would cause one to suspect that dangerous weapons are concealed here; there is a simple bank of sand and nothing else. Down behind it, however, are all the great rifles, crouched on their haunches, ready to spring up and show fight at a signal from the officer who controls them. For our benefit General Murray had one of these monsters maneuvered, he explaining the movements as they took place. The catch holding the gun in its lower position was released and the counterweight threw the rifle into place above the level of the parapet. Then, a light touch on the controller swung the muzzle to the right and to the left, and up and down. Of course when the gun is fired, the recoil seats it again in its recumbent position, but in this case, since no firing was done, it was brought down by hand, two men turning the crank and working hard to do it.

We were then shown some sub-caliber practice. We were told that this sub-caliber practice is largely responsible for the proficiency in marksmanship which the American artilleryman has shown. A small barrel, perhaps 2 or 3 inches bore, is placed inside the chamber of the big gun, being held in a truly central position by supporting disks. The weight and charge of the smaller projectile are such that its trajectory bears a definitely determined relation to that of the large projectile. It is thus as useful for target practice as though the $200 or $300 required for a single discharge of 12-inch ammunition was expended. It was some little time before they could get around to firing this sub-caliber ammunition. The passing body of visitors, not realizing that it was desired to fire the gun, all preferred to pass by its muzzle end, and each one stopped to gaze into the gloomy depths of its throat. Owing to the inconvenience of discharging the gun under such circumstances, everyone was allowed to satisfy his curiosity before the firing commenced. The sharp "spat" of this sub-caliber ammunition was so ridiculous when compared to the heavy reports we had just heard, that a number of us became quite brave, and gathered about the barrel of the gun, even getting to the point of leaning up against it and placing our hands on it. No one, however, showed any further desire to pass in front of the muzzle, although, so far as one could see, that would have been a perfectly harmless proceeding.

Sandy Hook as a Winter Resort.

After this exhibit, a long, chilly, windy walk took us to the mining casemate, where a description of the principles of sub-marine mine defence was given us. One great advantage of this lecture and exhibit was the fact that it was held in a hole in the ground entered only by a tunnel. Although open to the sky, this pit was so deep that there was not much

of any wind. After this respite, we turned our backs on the shore batteries and made our way toward the center of the peninsula where the mortar batteries were located. One could not help thinking, as he plowed through the sand and turned his face away from the biting wind, that life in this part of the world in winter, at least, possesses few charms. The officers and men were going about in fur caps and huge gloves, the women and the children of the post were all indoors, and all the inhabitants except the officers—whose dignity forbade them—seemed to enjoy slapping their chests as long and as hard as they could, when they had nothing else of particular importance to occupy their time. When, however, the soldiers were in line, receiving and executing orders, they were as straight and still and attentive to business, and as little conscious of the elements, as a soldier is supposed to be.

A Salvo from the Mortar Battery.

The mortar battery proved to be one of the most interesting exhibits of the day. The formation of the earthworks is that of a series of deep pits in the ground, possibly 40 or 50 feet deep or more. These pits are connected with each other by tunnels and have smooth concrete sides. At the bottom of each is a group of four 12-inch mortars, looking, as one man expressed it, like a lot of big bull dogs. We were to witness the firing of a "salvo"—that is to say, the simultaneous discharge of four of these guns at one time. It was explained to us that mortars were always aimed by the indirect method; as the enemy's ships are approaching, their range is rapidly obtained, calculations, facilitated by instruments provided for the purpose, are made to determine at what angle and in what direction the mortars shall be pointed, and then, after the aim has been taken, they are discharged. They cannot of course be fired point blank at the approaching vessel, but are aimed up in the air. The missiles go to a tremendous height and, in falling, come down nearly vertically on the deck, the weakest point of the approaching vessel. Strange as it may seem, the science of mortar firing has been developed to such an extent that they are fully as effective as rifles aimed directly at the object it is desired to hit.

Nowhere, as when we were grouped on the verge of these pits, did we realize so well at once the beauty of the day and the force and coldness of the wind. Long heavy swells were coming in from the southwest, whose tops, as they broke on the beach, were shattered by the gale from the north and whirled in a line of flashing spray that extended as far down the coast as the eye could reach. The herring gulls, which swarm the harbors of our Eastern cities during the winter, were flying in great flocks through the air or resting in countless numbers on the undulating surface of the ocean. A couple of huge freighters, from the East Indies perhaps, or some other foreign place, were steadily ploughing toward the great city to the north of us. Nearer in and to the southward, a little tug could be seen making her way toward us along the shore.

Meanwhile they had been loading the four 12-inch rifle mortars below us. The projectiles and powder bags were pushed into place, the breech blocks were closed, and the guns were aimed in accordance with instructions given by the officer who stood with us on the parapet—and then we waited for the firing. These guns looked very business like, all standing at attention with heads up, ready to do as they were told as soon as they were told to. Then came a dull boom and a trembling in the ground, and the pieces were fired. Away up in the sky, so far up that they were almost out of sight (in fact they finally did disappear) were four, or was it only three, little black specks side by side, headed in this round-about fashion for the definite little point out in the ocean at which they had been aimed. A few seconds later a column of spray shot in the air, and we knew that the projectiles were back to sea level again. The little tug shifted its course, and gave us a wider berth.

After this, from our elevated station, we were treated to the sight of an explosion of a mine laid in the sand. So far as one could see it lay in about the direction of the territory we had been tramping over some hours before. Over this same spot were also exploded, one after the other, four shells, two loaded with black and two with smokeless powder. These were fired from a point half a mile further back at the proving grounds. Again, congratulating ourselves that we had gotten away from that spot earlier in the day, we made our way back to the train and started for home.

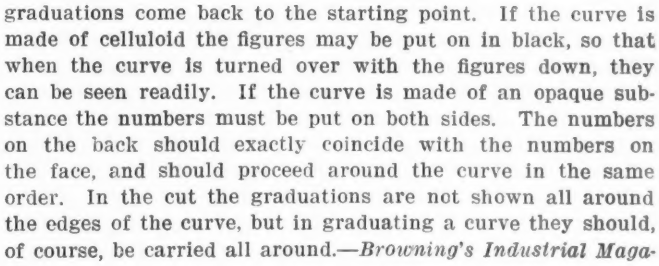
A Lesson in Journalism.

The papers in the city had a surprise for us when we returned. "Foreign spies at Sandy Hook—Attempt by foreigners to witness gun tests at Fort Hancock—Tried to board special train of engineers—Attempt believed, however, to have been foiled."—A sensation was caused when word was passed from car to car that President Hutton was holding up members and guests and requiring them to give evidence of their American citizenship." There were seven of the disappointed aliens in all; two Germans, an Englishman, a Japanese, a Frenchman, a Canadian, and a Scotchman. It seems that they were allowed to witness the tests at the proving grounds, but were entertained during the rest of the day in a comfortable steam-heated room in the post library, while the rest of us were shivering around the fortifications of Fort Hancock. One had the impression at the time that this "special courtesy" that was shown to the aliens was merely a matter of red tape and nothing more, but the newspaper reporters evidently saw a chance to make something startling out of it, and they gave a very interesting exhibition of the way in which most startling news is manufactured.

* * *

GRADUATED CURVE FOR DRAWING SYMMETRICAL LINES.

Many curves drawn by means of the so-called French curve, such as the ellipse, hyperbola and parabola, require that the same parts of the French curve are used on each side of the axis of symmetry. The regularity of the curve and the degree of perfection of the symmetry will then depend on one's ability to reproduce in proper sequence on one side of the curve the parts of the French curve used in drawing the other side first. The cut shows a curve graduated on its edges with some arbitrary divisions, say, in eighths. At every fourth one of these divisions a number is placed, starting with one at any convenient point on the curve and increasing by one until the



Draftsman's Graduated Curve.

graduations come back to the starting point. If the curve is made of celluloid the figures may be put on in black, so that when the curve is turned over with the figures down, they can be seen readily. If the curve is made of an opaque substance the numbers must be put on both sides. The numbers on the back should exactly coincide with the numbers on the face, and should proceed around the curve in the same order. In the cut the graduations are not shown all around the edges of the curve, but in graduating a curve they should, of course, be carried all around.—*Browning's Industrial Magazine.*

* * *

According to recent reports the largest wireless telegraph station in Europe is at present being erected at Norddeich, Germany, by the German postal department. The range of this station will be a circle of 950 miles radius and it will cover practically the whole of Europe, reaching as it will St. Petersburg at the north, and Naples at the south. The height of the tower of this new wireless telegraph station is 275 feet. Experiments undertaken so far have been successful in transmitting messages to steamers on the Norwegian coast, 650 miles away, across the Baltic as well as a considerable portion of the Scandinavian peninsula.

MACHINE TAPS.

ERIK OBERG.

As the name implies, the machine tap is used for nut tapping in tapping machines, the same as the tapper tap which was treated of in the December issue of MACHINERY. It was mentioned in that issue that the names of these two taps are often confused. From a manufacturing point of view, however, there is distinct difference between the two kinds of taps. The tapper tap embodies, in fact, the very simplest design possible for its purpose. It cannot be successfully used in many instances where the machine tap will be satisfactory. The machine tap being threaded and relieved in a different manner recommends itself for use in very tough material, and for heavy duty.

The general appearance of the tap may be seen from Fig. 4. It consists of a threaded portion *B*, having a straight part *D*

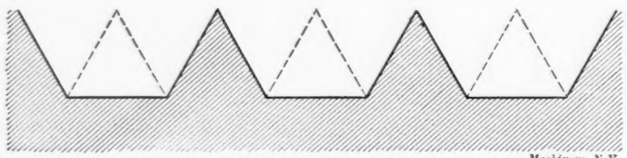


Fig. 1. Diagram of the Echols' Thread.

and a chamfered portion *E*, and a shank *C* which is provided with a square, enabling the tap to be securely held in a chuck without danger of slipping. The extreme end of the threaded part is provided with a secondary chamfer, the purpose of which is to facilitate the entering of the tap in the hole in the nut blank. The diameter of the shank should be from 0.01 to 0.02 inch below the root diameter of the thread, the same as for tapper taps and for the same reason, *viz.*, to permit the threaded nuts to slide freely over the shank.

Turning and Threading.

In turning machine taps the straight portion of the threaded part must be left a certain amount oversize. The reasons for this were set forth in the article upon tapper taps previously referred to. The amount which the tap should be left over the standard diameter before hardening may, for general purposes, be between the limits of from 0.0005 inch to 0.0015 inch for sizes not over ½ inch diameter, from 0.001 inch to 0.002 inch for sizes between ½ and 1 inch, from 0.0015 inch to 0.003 inch for sizes between 1 and 2 inches, and from 0.002 inch to 0.0035 inch for sizes between 2 and 3 inches in diameter.

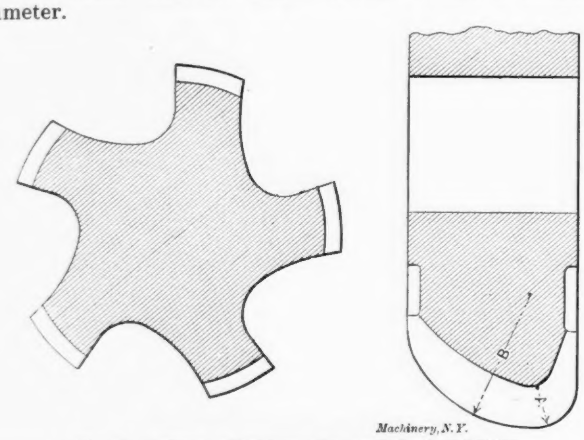


Fig. 2. Section of Machine Tap and Fluting Cutter.

The main difference between tapper taps and machine taps will be found in the threading and relieving of the taps. While the tapper tap is threaded straight for the whole length of the threaded portion, the machine tap is threaded on a taper for a certain distance from the point. The length of this taper thread, and also the length of the part chamfered on the top of the thread depends, of course, primarily upon the conditions under which the tap is to be used: the material to be tapped as well as the length of the nut. When making taps in large quantities, however, whether for the market or for shop use in a large establishment, it is evidently impossible to know beforehand exactly what the taps will be used for, and certain standards must necessarily be adopted. Experienced makers of machine taps adhere to the rule of chamfering about twenty to twenty-five threads on the top of the threads and taper the root of the thread for a distance equivalent to eight or nine threads from the point. Formulas will be found below which will give the length of the chamfered part and the length of the taper thread for various sizes of taps; these dimensions will be so selected as to provide for a length equivalent to at least twenty and eight threads, respectively, on standard thread taps.

While a long taper on a tap is desirable in regard to diminishing the amount of stock that each tooth of the thread will remove, it has the disadvantage of making the cutting edges toward the point of the tap very broad with a very small space between them. This impairs the cutting quality of the tap, inasmuch as the action is rather that of reaming than of cutting. It is in order to overcome this disadvantage that machine taps are tapered in the angle of the thread for some distance from the point. This makes the width of the tooth smaller and increases the cutting qualities of the tap considerably. This taper in the angle of the thread constitutes one of the principal differences between the machine tap and the tapper tap, the latter being simply chamfered off on the top of the threads. If we analyze the action of the tap when provided with too many cutting edges we will find that the metal is either ground down very fine, and an unnecessary amount of power is consumed in performing this, or some teeth may

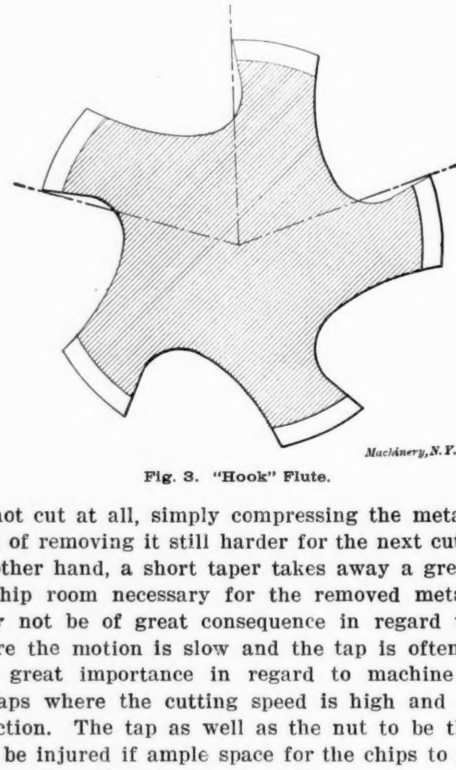


Fig. 3. "Hook" Flute.

in fact not cut at all, simply compressing the metal, making the work of removing it still harder for the next cutting edge. On the other hand, a short taper takes away a great amount of the chip room necessary for the removed metal. While this may not be of great consequence in regard to a hand tap where the motion is slow and the tap is often reversed, it is of great importance in regard to machine taps and tapper taps where the cutting speed is high and always in one direction. The tap as well as the nut to be threaded is liable to be injured if ample space for the chips to pass away from the cutting edges is not provided.

An ingenious method of decreasing the number of cutting edges, as well as increasing the amount of chip room, is embodied in the "Echols' thread," where every alternate tooth is removed, as shown in Fig. 1. The removal of every other tooth in one of the lands evidently is equivalent to the removal of the teeth of the continuous thread in every other land of the tap. It is therefore obvious that taps provided with this thread must be made with an odd number of lands, so that removing the tooth in alternate lands may result in removing every other tooth in each individual land. If there were an even number of flutes, the cutting away of the teeth in alternate lands would result in removing all the teeth from certain lands and none from the remaining ones. Machine taps are often provided with the Echols' thread.

Fluting.

In considering the fluting of machine taps we find another difference from the tapper tap. The former tap requires greater strength on account of its harder service, and at the same time as much chip room as possible. The flute that best fills these requirements may, however, not be the flute commercially possible for the purpose, because the factor of

cost is greatly important, and unusual or formed shapes of cutters will cost more in themselves and also require slower cutting speed. In the article about tapper taps, two forms of flutes were shown. Another form of flute introduced by the Pratt & Whitney Co, for machine taps is shown in Fig. 2. This latter form is to be recommended in all cases where a tap of unusual quality is required. The tap will not break as easily, and the chips are carried off in a more satisfactory manner. A certain kind of flute of late used extensively by certain concerns is the "hook" flute, shown exaggerated in Fig. 3. This flute provides for a keener cutting edge, and is recommended for very tough materials. Some users, however, do not look upon this flute as favorably as others, and opinions vary considerably as to the superiority of this flute, excepting if the "hook" be made very slight. It is advisable to make the lands fairly narrow as compared with hand taps, inasmuch as this will increase the chip room and but slightly decrease the strength, the reason for the wide lands of hand taps being not reasons of strength but of good guiding qualities. If provided with a straightsided flute with a radius in the bottom, which is largely used by manufacturers, this radius may be approximately determined by the equation:

$$R = \frac{\sqrt{D}}{6} - \frac{1}{32}$$

R being the radius in the bottom of the flute and D the diameter of the tap. In the case of a fluting cutter such as shown in Fig. 2 the radius A should be about one-eighth and the radius B about one-third of the diameter of the tap for taps with five flutes. For taps with four or six flutes these radii should be slightly larger or smaller, respectively, relative to the diameter of the tap. The numbers of the flutes for various diameters are given below:

Diameter of Tap.	No. of Flutes.	Diameter of Tap.	No. of Flutes.	Diameter of Tap.	No. of Flutes.
$\frac{1}{4}$	4	$\frac{3}{4}$	5	2	5
$\frac{5}{16}$	4	$\frac{7}{8}$	5	$2\frac{1}{4}$	6
$\frac{3}{8}$	4	1	5	$2\frac{1}{2}$	6
$\frac{7}{16}$	5	$1\frac{1}{4}$	5	$2\frac{3}{4}$	6
$\frac{1}{2}$	5	$1\frac{1}{2}$	5	3	6
$\frac{5}{8}$	5	$1\frac{3}{4}$	5	..	..

Relief.

Machine taps are relieved as well in the angle of the thread as on the top of the thread for the whole of the chamfered portion, or in other words, the diameter measured over the heel of the thread should be smaller than the diameter measured over the cutting edge; the diameters measured in the angle of the thread at the same respective places should also differ in the same manner. The straight portion of the thread in a machine tap is for sizing only, the same as in the case of a tapper tap, and should as a rule not be relieved. However, the same as was said about the relief of the straight part of a tapper tap applies here also. In hardening machine taps they should be drawn to a temper of about 430 degrees F. This temperature should, perhaps, vary for different kinds of steel, but the figure stated will be found to constitute a good average.

Dimensions.

In the following are given two sets of empirical formulas for the most important dimensions of machine taps. In the formulas:

A = the total length of the tap,
B = the length of the thread,
C = the length of the shank,
D = the length of the parallel part of the thread,
E = the length of the chamfered part of the thread,
F = the length of the taper threaded portion,
G = the diameter of the tap.

For taps up to and including 2 inches in diameter, the following formulas will be suitable:

$$A = 5\tfrac{3}{4}\,G + 3\tfrac{7}{8},$$
$$B = 2\tfrac{1}{2}\,G + 1\tfrac{1}{4},$$
$$C = 3\tfrac{1}{4}\,G + 2\tfrac{5}{8},$$
$$D = \tfrac{3}{4}\,G + \text{3-16},$$
$$E = 1\tfrac{3}{4}\,G + \text{1 1-16},$$
$$F = \frac{3G + 1}{4}.$$

For taps 2 inches in diameter and larger the formulas will be:

$$A = 3\,G + 9\tfrac{3}{8},$$
$$B = 1\tfrac{1}{2}\,G + 3\tfrac{1}{4},$$
$$C = 1\tfrac{1}{2}\,G + 6\tfrac{1}{8},$$
$$D = \tfrac{3}{8}\,G + \text{15-16},$$
$$E = 1\tfrac{1}{8}\,G + \text{2 5-16},$$
$$F = \frac{2G + 3}{4}.$$

The table below is based upon the formulas given. All dimensions are given in convenient working sizes, and are approximate in such cases where the formulas give values which cannot be expressed in even fractions, or give fractional values inconvenient for working figures.

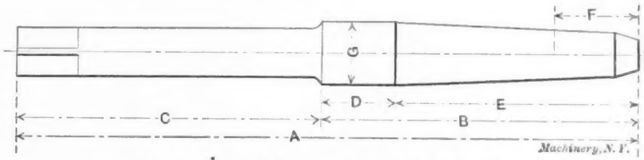


Fig. 4. General Appearance of Machine Tap.

DIMENSIONS OF MACHINE TAPS.

G	A	B	C	D	E	F
$\frac{1}{4}$	$5\frac{5}{16}$	$1\frac{7}{8}$	$3\frac{7}{16}$	$\frac{3}{8}$	$1\frac{1}{2}$	$\frac{7}{16}$
$\frac{3}{8}$	$6\frac{1}{16}$	$2\frac{3}{16}$	$3\frac{7}{8}$	$\frac{7}{16}$	$1\frac{3}{4}$	$\frac{9}{16}$
$\frac{1}{2}$	$6\frac{3}{4}$	$2\frac{1}{2}$	$4\frac{1}{4}$	$\frac{9}{16}$	$1\frac{15}{16}$	$\frac{5}{8}$
$\frac{5}{8}$	$7\frac{1}{2}$	$2\frac{13}{16}$	$4\frac{11}{16}$	$\frac{5}{8}$	$2\frac{3}{16}$	$\frac{3}{4}$
$\frac{3}{4}$	$8\frac{3}{16}$	$3\frac{1}{8}$	$5\frac{1}{16}$	$\frac{3}{4}$	$2\frac{3}{8}$	$\frac{13}{16}$
$\frac{7}{8}$	$8\frac{15}{16}$	$3\frac{7}{16}$	$5\frac{1}{2}$	$\frac{13}{16}$	$2\frac{5}{8}$	$\frac{15}{16}$
1	$9\frac{5}{8}$	$3\frac{3}{4}$	$5\frac{7}{8}$	$\frac{15}{16}$	$2\frac{13}{16}$	1
$1\frac{1}{8}$	$10\frac{3}{8}$	$4\frac{1}{16}$	$6\frac{5}{16}$	1	$3\frac{1}{16}$	$1\frac{1}{8}$
$1\frac{1}{4}$	$11\frac{1}{16}$	$4\frac{3}{8}$	$6\frac{11}{16}$	$1\frac{1}{8}$	$3\frac{1}{4}$	$1\frac{3}{16}$
$1\frac{3}{8}$	$11\frac{13}{16}$	$4\frac{11}{16}$	$7\frac{1}{8}$	$1\frac{3}{16}$	$3\frac{1}{2}$	$1\frac{5}{16}$
$1\frac{1}{2}$	$12\frac{1}{2}$	5	$7\frac{1}{2}$	$1\frac{5}{16}$	$3\frac{11}{16}$	$1\frac{3}{8}$
$1\frac{3}{4}$	$13\frac{15}{16}$	$5\frac{5}{8}$	$8\frac{5}{16}$	$1\frac{1}{2}$	$4\frac{1}{8}$	$1\frac{9}{16}$
2	$15\frac{3}{8}$	$6\frac{1}{4}$	$9\frac{1}{8}$	$1\frac{11}{16}$	$4\frac{9}{16}$	$1\frac{3}{4}$
$2\frac{1}{4}$	$16\frac{1}{8}$	$6\frac{5}{8}$	$9\frac{1}{2}$	$1\frac{3}{4}$	$4\frac{7}{8}$	$1\frac{7}{8}$
$2\frac{1}{2}$	$16\frac{7}{8}$	7	$9\frac{7}{8}$	$1\frac{7}{8}$	$5\frac{1}{8}$	2
$2\frac{3}{4}$	$17\frac{5}{8}$	$7\frac{3}{8}$	$10\frac{1}{4}$	$1\frac{15}{16}$	$5\frac{7}{16}$	$2\frac{1}{8}$
3	$18\frac{3}{8}$	$7\frac{3}{4}$	$10\frac{5}{8}$	$2\frac{1}{16}$	$5\frac{11}{16}$	$2\frac{1}{4}$

* * *

THE SPOTTER IN THE SHOP.

There may be a better word to express just the same meaning as is expressed by the above title, but if so it is not in the dictionary, and it wouldn't look well in print, and therefore this will have to stand.

We all have met him; he works in every shop from Maine to California. Sometimes he has charge of a department, but he seldom gets as high up as that. He depends more upon his capillary powers to hold a job than he does upon his ability as a workman. If you are a good workman you need never object to his presence in the shop; in fact, it is often of advantage to a good man to have him; but we all detest the principle which allows or compels an employer to use him. He must be regarded by the firm as a necessary evil that cannot be avoided, somewhat similar to the use of cotton waste; you use it, and get all you can out of it, and then chuck it out of sight as soon as you are done with it.

I have worked in shops where there were one or more in every department, and everything said or done went to the office on the "underground" route as soon as it happened. But it does not pay to act as a "spotter" when the old man is not of that kind of stuff as to appreciate your efforts. A good thing of this kind happened at the works of the * * * Company many years ago, which has the merit of being true. One of the men went to the "Professor" with a tale of woe: "There is a man up in room 16 who has a shop down in the basement of his house, and he is experimenting all the time evenings, and he steals all his stock in the shop." "Is that so?" said the "Professor," very much interested. "Well, if you will kindly tell him this for me, that any time he has any trouble stealing all the stock he needs or wants, let me know, and I will see that he has an order for all that he needs." It was a clear case of the spotter getting left.

One more case that came up will show the disadvantages of the "spotter system." A foreman had in his department a large amount of work stowed away under the bench. It was piece work; had been inspected, passed and paid for, and was simply stored there with the knowledge and at the wish of the foreman of the stockroom, who didn't have room to receive it. The spotter didn't know all this and thought it was piece work that was being held back and hadn't been paid for, and was done with the connivance of the foreman. Now, all you boys who read this, and have done contract work, will know just what I mean, so Mr. Spotter puts in his report to the office. The whole matter could have been investigated and settled without any trouble and without the foreman's knowl-

. . . "Caused by breaking off a tap at the bottom of a deep hole."

edge, but instead of that, Mr. Spotter was so sure about the matter that the foreman was called on the carpet to explain. When he had done this to the complete satisfaction of the management, as he turned to leave the office, he couldn't help giving them this shot: "If you had only waited until you got the *next* report from that spotter of yours, it would have saved you all this trouble." A. P. Press.

Mr. Editor: The above was written while recovering from a bad attack of the blues, caused by breaking off a tap at the bottom of a deep, deep hole in a big casting. A. P. P.

* * *

Everyone working at the bench, desk or drafting table likes to have plenty of light, but as the direct glare of sunshine is intolerable, it is generally necessary to screen off the light of windows on the sunny side of the building with shades or ground glass so as to subdue and diffuse the light and thus relieve its intensity. Unfortunately this usually means that a large part of the light is shut out. A scheme which subdues and diffuses the light without greatly reducing its volume was described by Mr. W. J. Thompson at a recent meeting of the Illuminating Engineering Society in New York. He hangs a large sheet of tracing cloth over the windows; the light coming through the tracing cloth is apparently as bright as the direct sunlight but it is diffused, lighting up a room in very much the same manner as an ordinary skylight. He tried the tracing cloth scheme after trying to get proper illumination in other ways, using screens, awnings, shades, etc., but has found that the tracing cloth shades answer the purpose the best of all. The hint is one well worth consideration in the drawing room and is a scheme easily tried as the material is always at hand for a trial. It may be that the simple tracing cloth scheme answers the purpose for which expensive prismatic glass arrangements are often installed; that is, to throw light to the dark side of a room.

MAKING BLANKING DIES TO CUT STOCK ECONOMICALLY.*

C. F. EMERSON.

A most important point for the diemaker to bear in mind in making blanking dies for odd shapes is to lay them out so that the minimum amount of metal will be converted into scrap. In fact, hardly too much stress can be laid upon this one point alone. It is an easy matter to waste a considerable

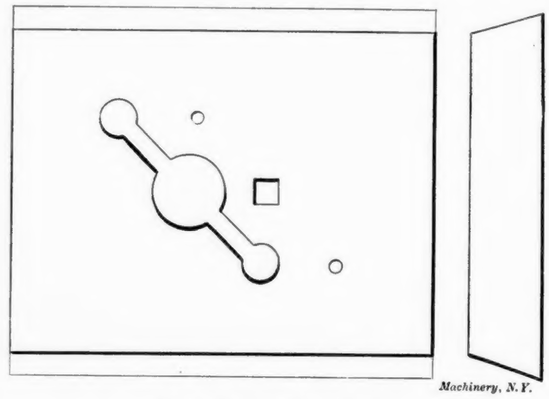


Fig. 1. Plan of Blanking Die.

percentage of the stock by lay-outs which may *appear* to be fairly economical. The diemaker should make a careful study of the most economical relation of blanking cuts to one another and to the stock. It is the object of the following article to point out by actual examples how stock can be saved which might be converted into scrap if the diemaker is not constantly watching out for possible economies. As an illustration, it

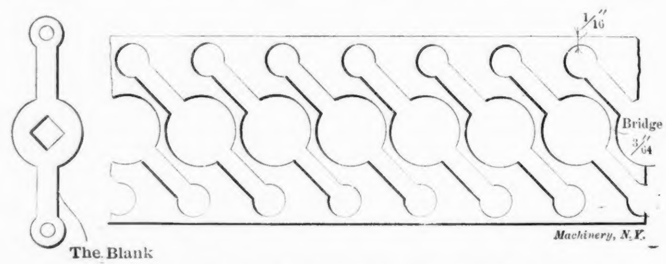


Fig. 2. Section of Stock after having been run through Die in Fig. 1.

sometimes happens that by laying out the dies so that the blanks are cut from the strip at an angle of 45 degrees, as shown in Fig. 2, a considerable economy of metal can be effected over a right-angle arrangement, that is, one in which the dies are set so as to cut the blanks straight across the strip. The angular location permits the use of narrower stock and materially reduces the amount of scrap metal. Fig.

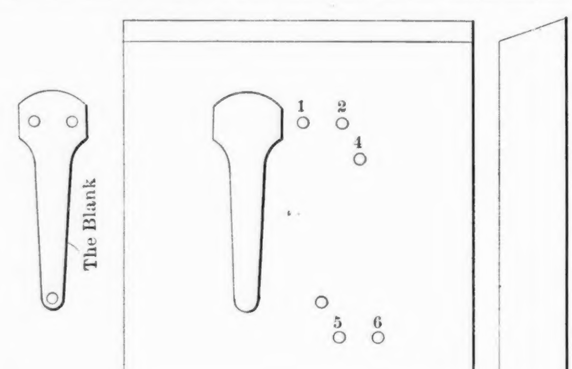


Fig. 3. Another Example of Blanking Die.

1 shows the plan of the die, and needs little or no explanation as the manner in which it is laid out is obvious; the plan of the strip shown in Fig. 2 also clearly shows how the die is laid out.

Another method that is often used to save metal is that shown in Figs. 4 and 5. This method is used where the re-

* This article is a continuation of the articles on die-making by Mr. Emerson, which appeared in the June, 1906, and October, 1906, issues.

quired amount of blanks does not warrant the making of a double blanking die; also when, unavoidably, there is a considerable amount of stock between the blanks after the strip has been run through as shown at *A* in Fig. 4. To save this metal the strip is again run through in a reverse order after the manner shown in Fig. 5, thereby using up as much of the metal as it is possible to do.

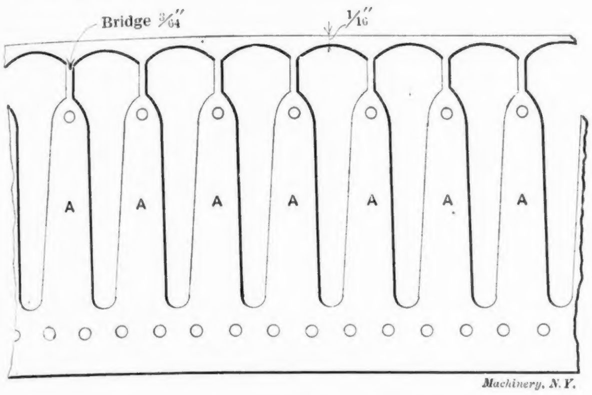


Fig. 4. Stock after having once been run through Die in Fig. 3.

Besides blanking and piercing the blank when running the metal through the first time the holes numbered 4, 5, and 6, Fig. 3, are also pierced. This is done for the reason that when the metal is run through the second time it prevents cutting of "half blanks" by "running in," or, in other words,

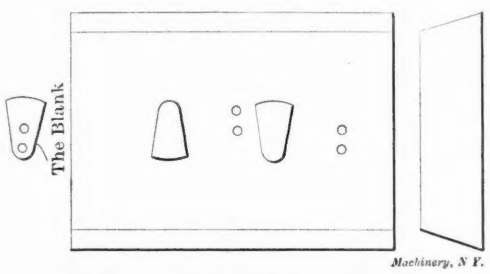


Fig. 6 A Third Example of Blanking Die.

the liability of cutting imperfect blanks by cutting into that part of the metal from which blanks have already been cut. This guiding action is effected by three pilot pins in the blanking punch (not shown) which engage in the three pierced holes, made when the strip was run through the first

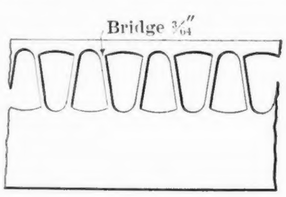


Fig. 7. Stock after having been run through Die in Fig. 6 once.

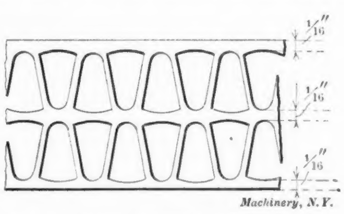


Fig. 8. Stock having twice been run through Die in Fig. 6.

time. The pilot pins engaging with the pierced holes cause the second lot of blanks to be cut centrally with the holes; also to be accurately centered between the portions of stock from which the blanks have already been cut. When this die is in use the metal is run through in the usual way from

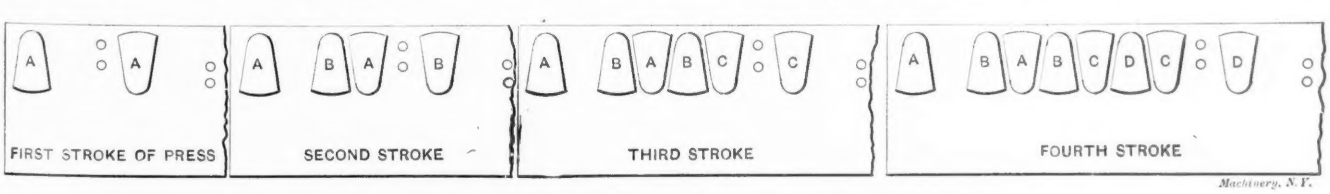


Fig. 9. Appearance of Stock after each successive Stroke of the Press.

right to left until half of the required amount of blanks are cut, after which the piercing punches for the holes are taken out and the metal is run through again and the other half of the required amount of blanks is cut.

In laying out this die which is done after the manner shown in Fig. 11 the line *A* is used as a center line for the piercing holes numbered 1 and 2 in Fig. 3, and the line *B* is the center line of the blanking part of the die. The line *C* is the center line that shows the center of the next blank to be cut and is laid out 53/64 inch from the line *B*. This dimension is fixed by the fact that the widest part of the blank is 25/32 inch and the bridge between the blanks is 3/64 inch, the sum of which equals the distance from center to center of adjacent

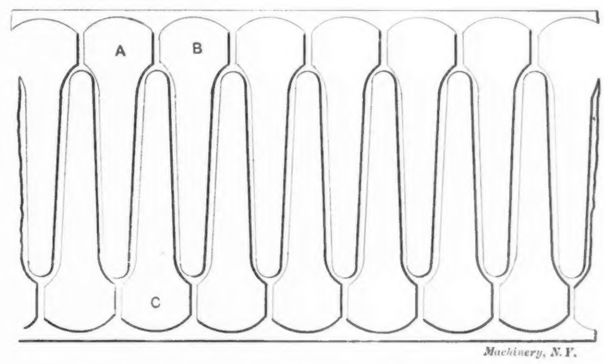


Fig. 5. Stock after having been run through Die in Fig. 3 twice.

blanks. The line *D* is the center line for the blank *C*, Fig. 5, that is cut when the metal is run through the second time, and is made at 0.414 inch or one-half of 53/64 from the line *C*, Fig. 11, inasmuch as the blank is cut centrally between that part of the metal from which the blanks *A* and *B*, Fig. 5, are cut.

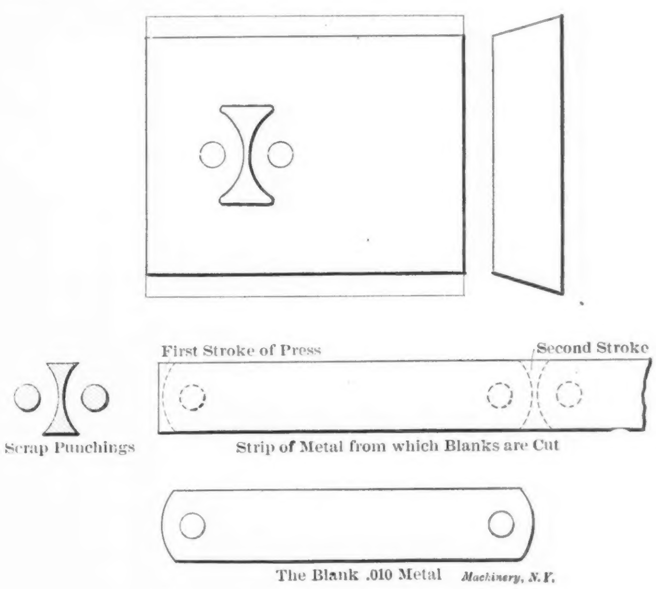


Fig. 10 Blanking Die for Producing Links.

Fig. 6 shows a double die for blanking and piercing brass, producing the shape shown in the sketch at the left; it is laid out so as to save as much of the metal as practically possible without added expense in so far as the operation of blanking and piercing is concerned. By referring to Figs. 7 and 8 it can be seen that the strip of metal from which the blanks are cut is run through a second time for reasons that will be given. One reason is that wider metal can be used by doing so which in itself is a saving in so far as the cost of metal is concerned. Wide brass can be bought at a lower price per pound than narrow brass; the other reason is that a strip of metal 1/16 inch wide and as long as the entire length of the strip is saved on every strip that is run through. If

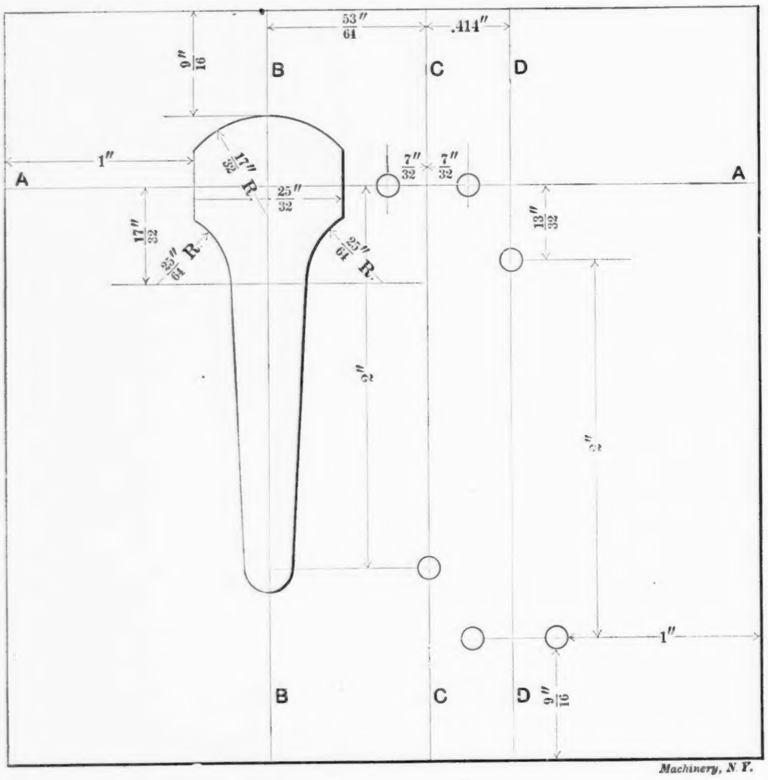


Fig. 11. Layout of Die shown in Fig. 3.

narrow metal were used there would be a waste of 1/8 inch of metal (*i. e.*, 1/16 inch on each side) of every strip run through. But on two strips from which no more blanks can be cut than from the wider strip shown in Fig. 8 there would be a waste of 1/4 inch of metal. On the other hand, by using wide metal the waste would be only 3/16 inch, as indicated in the cut. Fig. 12 shows how this die is laid out and should be sufficiently clear to explain itself and thus requires no further words.

To fully understand the manner in which the metal is gradually worked up after each stroke of the press, short sections are shown in Fig. 9. At the first stroke four holes are pierced and two plain blanks—with no holes—*A A* are cut out. At the second stroke there are also four holes pierced and the two blanks *B B* are cut that have the holes pierced at the previous stroke. At the third and fourth strokes the holes begin to match in with each other, as shown so that when the metal is run through it will look like the strip shown in Fig. 7.

It should be borne in mind that four holes are pierced and two blanks are cut at each stroke of the press; also that the

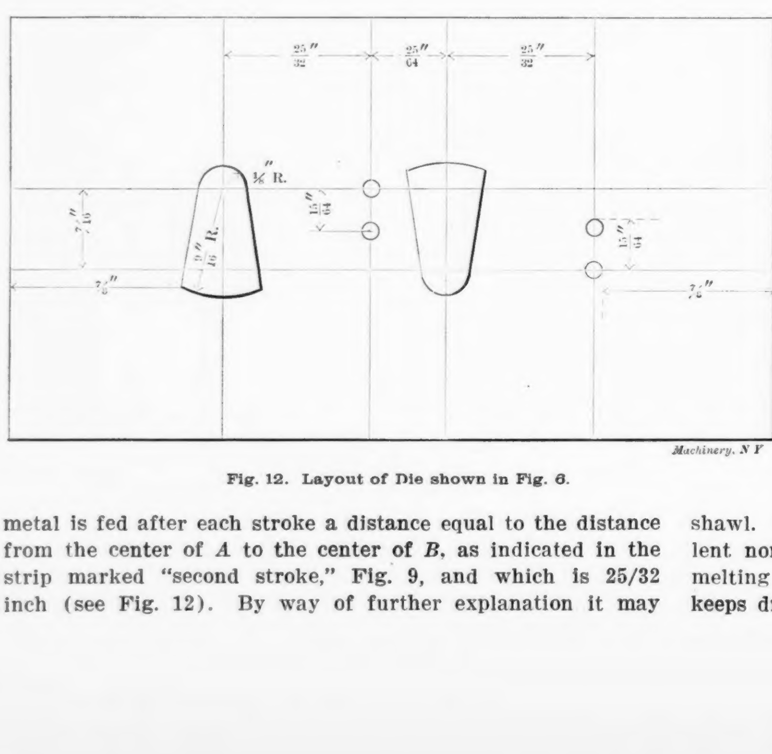


Fig. 12. Layout of Die shown in Fig. 6.

metal is fed after each stroke a distance equal to the distance from the center of *A* to the center of *B*, as indicated in the strip marked "second stroke," Fig. 9, and which is 25/32 inch (see Fig. 12). By way of further explanation it may not be amiss to state that the distances from the center of *A* to *B*, *B* to *C*, *C* to *D*, and *D* to *C*, as shown in the strip marked "fourth stroke" are each 25/64 inch, or half of 25/32 inch.

While the dies shown in Figs. 10 and 13 are commonly known it may not be out of place to say a few words with reference to them as they form an important part in the economical production of sheet metal goods. The first or Fig. 10 shows a die that is used to produce from narrow ribbon a long blank with rounded ends and with a hole pierced in each end. The principal features of this style of die are that there is very little waste of material in the production of the blanks, as will be noted from the sketch of the scrap punchings shown at the left, and the other feature is that by the aid of an adjustable stop, not shown, almost any length of blank can be made without altering or resetting the tools after they have been set up in the press. The working part of the die is laid out a little to the left of the center so as to give sufficient length for the gage plates which are fastened to the die by 1/4-inch cap-screws. These gage plates are used to keep the metal in position while it is being fed from right to left as the blanks are cut from the strip.

Fig. 13 is a combination piercing and shearing die and is used for producing the 1-inch square washer shown in the cut. The principal feature of this die is that there is no waste of metal in producing the blank, only, of course, the 1/4-inch round punching taken from the center. The strip of metal in

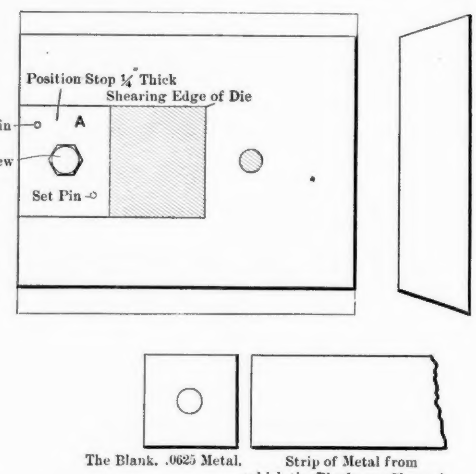


Fig. 13. Blanking Die for Square Washers. Shaded Portions in Die indicate parts punched out from stock

this case can be fed from right to left or front to back as preferred.

* * *

An interesting note in the columns of a contemporary describes a new refrigerator which is "lined with solid white stone mined in the company's own quarries." The statement is made that this stone is almost *ice cold* itself and is therefore specially well qualified to keep the provision chamber at a low temperature and save ice. It is a not uncommon idea that any material which feels cold to the hand must necessarily be a good refrigerating medium. As a matter of fact the colder a piece feels the poorer it is as an insulator, and insulation is largely the secret of refrigerator efficiency, of course. The feeling of cold is due to the conduction of heat away from the hand. The best insulator is that which feels "warm." No simple covering will keep a chunk of ice better than a thick woolen shawl. The shawl has no warmth in itself but is an excellent non-conductor of heat, hence it preserves the ice from melting better than almost any other material so long as it keeps dry.

APPRENTICESHIP EDUCATION.

ENTROPY.

While I have to thank Mr. Strong for his good opinion as expressed in his article (November issue), I thank him more for the opportunity which he seems to give me to sum up the various articles on apprentice education which I have written from time to time under various pen-names. I have tried in the past to present my plan a bit here and a bit there, seeking to interest as many as possible and knowing that the very men whom I wish to reach are the busiest and have the least tendency to begin to read long and learned articles. While the subject is more or less of a hobby with me I am still sufficiently disinterested so that I can take any suggestions in the spirit in which they are sent. My work in this line is not for my personal gain at all, for while I would like to be in at the start of any school or shop organization I do not care to follow it up for a livelihood. With this in mind as well as to persuade Mr. Strong that my plan as a whole covers his point I will put the whole thing as concisely as possible. My plan involves a shop and revolves about the shop as its central idea. The shop must be a commercial shop—absolutely must. Preferably it should make a large enough range of work so that it may train the boy with mechanical ability and incapacity for fine work as well as the boy to whom close measurement is a pleasure.

Then there must be a school in which should be taught those things which are of *direct* use to a machinist, foreman, or master mechanic. No others. This must be religiously adhered to. Otherwise the result will be that some ambitious teacher will make a third-grade engineering school of it. The control of the school must be from the shop to secure its subordination. The division of time should, for commercial reasons, be made such that half the boys are running machine tools all the time. The other half should be divided between school-room work, drafting, and hand work. The length of time which the boys stay in either division should not be over a week.

Pay.

For any man to be content he must feel that he is making a good thing of it. You can pay a man in money or in something which he can reasonably expect to turn into money later. With boys of the class that we must expect to take, money is the best with which to appeal. If they are to be paid in money it must be an equitable payment for what is done. As Mr. Strong hints, when a boy goes into a shop he is enthusiastic and works around lively. As soon as he gets so that he can do something commercially well he finds that he is kept in it as long as he will stand it, without increase of pay. He does not feel that he is being treated right if he does a man's work without a man's pay. His employer tells him that it has cost him good money to teach the apprentice to do this work. If the apprentice has any head for mathematics at all he can figure pretty close to what it has cost the firm to have the foreman stop and make fun of him a few times and show him about once how to do a little job. No wonder he gets listless.

Instead of paying by the hour, pay by the piece. For finished work done acceptably pay a little less than the journeyman's rate to cover increased length of time the apprentice ties up a machine. Charge the boy a certain amount for teaching him each step of his progress. Have him pay cash or work it out by keeping at this one style of job after he has gotten so he can work a commercially acceptable job. If he wants more money to spend or to live on let him work on this same job till he has earned enough to satisfy him. The average boy would stay on the job till he was really pretty expert at it, and I think be very content. The employer would know just how he was coming out at the end of the term of apprenticeship. If a shop is not already on a piecework or premium basis it would mean quite a little work to arrange for the apprentices so that they would get a consistent course and have their piecework or premium rates fair to both sides.

Class of Boys to become Apprentices.

The present and ever present need of the shops is for skilled workmen who can work with judgment. If such boys as now go to technical schools are selected they will become good machinists, but they will not be content to stay machinists long. They will want to and will go higher. It is apart from my purpose to discuss the relative merits of engineers trained in this way and those trained in technical institutions. But this seems sure to me that for an apprentice system to be successful from a manufacturer's point of view its recruits have to be from a stage in life where \$15 or \$18 a week looks big. To such boys the possibility that if they are diligent they may become leading hands or foremen, or that occasionally one may rise to be a master mechanic, a superintendent, will be enough to attract them. The examination then for admission to such a school should set an upper limit above which a candidate should not pass, as well as a lower limit, which he must equal.

Foremen and Teachers.

To ask the regular shop foreman to take apprentices under his charge and give them the attention they need is an injustice to him. His business is to produce work, not teach. He has to earn his salary if he does his legitimate work. More than that, it is rarely the case that a foreman who is good with the boys is good for much as a foreman. While school-room teaching in addition to the present loose method in the shop would be better than nothing I hope no one will think that I prefer the makeshift which I suggested in the August issue to this main plan. In a shop I would suggest a room partitioned off, as they do in Lynn, from the rest of the shop, but I should keep the boys there full two years of their course in contact only with the best of leading workmen.

These instructors should be men of experience but they should be young enough to have active interest in their work and they should know that their future pay will depend exclusively on results obtained. The instructor in machine work should be a good clean-cut mechanic whose experience and judgment renders him capable of all grades of work, and who can take hold and show the boys. The instructor in the school room should be some young man, say a draftsman with technical education who has been out long enough to have forgotten all his calculus and most of his trigonometry, a man who knows what methods will give solutions of everyday problems with the least mental effort. No teacher of the usual educational type need apply. No one will do who cannot pick up out of his memory a lot of really useful problems.

How a Small Shop can Afford to Start a School.

I should say that a shop with a dozen boys is the lowest number possible. More will be better. With so few boys the shop instructor might do some work himself at the lathe or bench though I mistrust that it would pay to have him right around the boys all the time, even with so small a number. For equipment give them tools already in use in the shop. Not the most antiquated in design but something modern. If badly worn let the best of the boys repair them. Have them keep the tools up in good shape too. The reason for putting the boys all in one room for so long a time is this. Almost all shops have a pacer, or a man who sets the gait at which the rest go. Such a man makes it impossible to get an apprentice to set any faster pace. What is wanted is men who follow no pace but their own. They are wanted badly enough so that they can command their own price and their own hours within reason. If the boys do not know anybody else's pace and are paid piece or premium rates they will, as they grow expert, tend to set a pace which will make them valuable to a point of healthful independence.

Cost.

This is not a philanthropic scheme at all. Unless it pays it neither will be done nor ought to be done. Unless boys can be held by nothing more than their own self-interest they ought not to be held. The old-time apprentice system said to a boy: "Come in and I will teach you a trade. But you must put yourself entirely in my power, be my slave for a term of years." In itself it was an admission that when the boy found out how he was to be treated he would quit if he could. Unless a contract is mutually agreeable it

is a poor contract for either party in the long run. Under my plan we will say to a boy: "Come in and for a certain price we will teach you to do a certain job. We will guarantee you work at fair pay on that job long enough so that you can afford to pay our price. Then if you want to learn another step of the trade we will teach it to you and you shall pay us for doing it. You may leave any time that you think you have learned enough. If you come in you must attend our school and get what you can out of it." Under this plan it is perfectly feasible to so set piece work or premium rates that the proprietor may know pretty closely where he will come out at the end of the year. He ought to come out a trifle ahead. The boy's self interest will keep him working on a job long enough to get some money ahead which will insure his dexterity. His self-interest will make him take up the next job as soon as he can afford it and will make him learn as fast as he can so that he can get to making money. His self-interest will keep him faithful in school for just the same reason that men are faithful to their correspondence school work.

The thing which yet remains to be accomplished before anything can be started is to persuade manufacturers that for their own safety in the future the country needs skilled, intelligent, native workmen; men who can stand on their own bottom and do the work which is needed to keep this country commercially ahead of the world, and men who need hide behind no organization to command the respect of their employers, and men who can and will bring skill and judgment to their work so that they may command compensation beyond the dream of any organization.

* * *

WEIGHT OF TIN PLATES.

The accompanying table by Mr. Horace Chrisman, East Pittsburg, Pa., contains some very useful data on tin plates. It includes the different denominations of tin plates and the corresponding number of the United States standard gage; also the nearest Brown & Sharpe gages and the actual thickness in decimals of an inch. The thickness of tin plate varies according to the coating of tin retained on the surface of the sheet. About two or three numbers of Brown & Sharpe gage should be added to the above columns marked with the asterisk to get the thickness of tinned plates.

WEIGHT OF TIN PLATE PER SQUARE FOOT.

Trade Designation of Gage.	Fraction of a Pound TinPlate.	Ozs. TinPlate	U. S. Standard Gage.	Nearest B. & S. Gage.	Thickness in Decimal Parts of an Inch.
IC	0.5	8.0	30*	28*	0.0125*
IX	0.625	10.0	28	26	0.015625
IXX	0.711	11.37	26½	24	0.018930
IXXX	0.8	12.8	25½	24	0.020300
IXXXX	0.9	14 4	25	23	0.021875
IXXXXX	1.0	16.0	24	22	0.02500
DC	0.64	10.25	28	26	0.015025
DX	0.83	13.25	25½	24	0.020300
DXX	0.97	15.5	24	22	0.02500
DXXX	1.11	17.8	23	21	0.028125
DXXXX	1.25	20.0	22	20	0.031250

* Thickness of black sheet before tinning.

* * *

There is a decided difference between a true mathematician and one who is "quick at figures." The true mathematician is a logician; he deducts certain facts and relations by a course of reasoning and proves them by calculation. If the figures do not prove his deduction he is more likely to look for the fault in the calculation than in his course of reasoning, for its very logic denies the possibility of error. The one quick at figures must, of course, be something of a logician but there is the difference that the first uses calculations as the means to prove a logical deduction, while the other always uses concrete quantities to get a definite result, and with, perhaps, only a dim idea of the mathematical principles involved. The use of a general expression to cover all possible cases of a given problem does not appeal to the "figurer" but it is just what the mathematician always seeks.

TEMPERING HOLLOW MILLS AND OTHER TOOLS.

J. F. SALLOWS.

The art of tempering high-class tools is understood by few mechanics; the majority of them know little or nothing whatever about tempering even so common a tool as a cold chisel. They think that standard sized tools bought in large quantities by factories throughout the country, which are stamped "B. & S,," "P. & W.," or some other well-known firm name, must be O. K., and often they would give a great deal to know just how to temper tools as well as these are tempered. This blind faith sometimes is the cause of amusing incidents. I have known a machine shop foreman to send a number of machine steel pieces into the smith to be annealed so they could be drilled. Upon investigation it was found that a new drill was too soft to drill anything except lead or pine, but after hardening, the pieces referred to were easily drilled. The fact of the matter is that the foremen and men under them often take for granted that because a drill is a twist drill and bought from a well-known concern it must, of course, be perfect, but if it were made in the shop where the work was being done and proved faulty they would very likely blame the man who did the tempering—even if it was done as it should be.

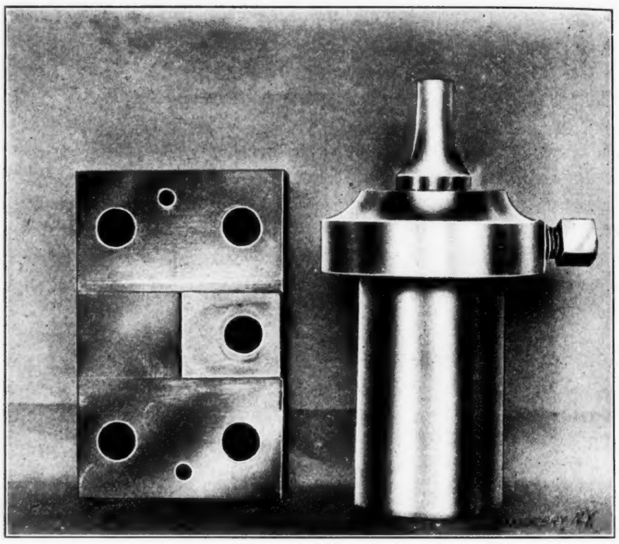


Fig. 1. Punch and Die having a Good Record. Hardened, but not Drawn.

In my experience of twenty-seven years on nearly all kinds of tools I find that each and every kind of tool has to be tempered in a way that suits its individual peculiarities and the class of work which it is intended to do. For example, I would not temper a tool for cutting brass the same as one for cutting machine steel, but nothing is more common than to find a smith tempering all lathe tools alike. This lack of discrimination is the cause of a great deal of trouble in all large plants. The man about to use the tool does not inform the smith who tempers it what the tool is required to do. Therefore, it is impossible to give general satisfaction. The smith who does the tempering blames the steel, and the one using the tool blames the smith and the tempering. As an example of my system I will write at this time about tempering hollow mills and explain what I claim to be the only correct method of tempering them to give satisfaction.

I cannot explain—nor can anyone else satisfactorily—why it is necessary to heat a tool up to a high lemon color and quench it off in cold water, then clean it all over, polish, rub, and perhaps spend ten hours time on what could be done in two hours. This may seem like a radical statement, but it will not appear so when I can prove to you that I can temper a three-inch mill and have it ready for work in twenty minutes. I have seen large tools hardened and put on the bench to be cleaned all over before being drawn to a light or dark straw as the case may require, but I never could find out whether the color was that of pea straw or rye straw (we can, by the way, draw machine steel to a nice straw). I have seen three punches tempered and drawn to the same color;

one was too soft to be of any use and the other two broke similar to cast iron. The difference in action was due to the way in which they were heated. Drawing a tool carefully to color cannot let you out if you do not watch your hardening heat. But, to return to the tools on the bench to be cleaned; when the man was ready to do the cleaning he found instead of having six tools he had eighteen parts of tools. The blame for this catastrophe was laid to the steel when the workman himself was at fault for going at a job he knew nothing about; before he was ready to relieve the so-called

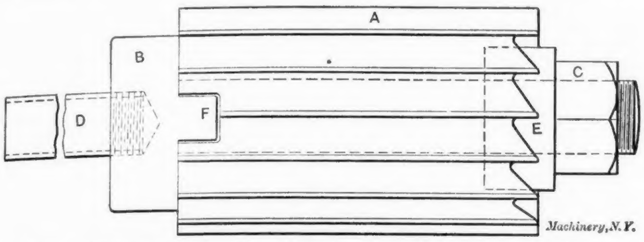


Fig. 2. Mandrel and Handle with Hollow Mill Mounted for Hardening.

internal strains they had relieved themselves, but why have internal strains to relieve? If the tempering smith will temper tools as I am about to explain he will have no internal strains to bother with, and the workman will have a milling cutter that will do more work and give better satisfaction than any internal-strain-relieved straw-colored tool that was ever tempered by any smith in any shop. As an example the accompanying halftone, Fig. 1, shows a 7/16-inch punch and die that has punched 100,000 holes in ¼-inch machine steel, or the equivalent of 25,000 lineal inches. The punch and die are still at work; it is interesting to know that they were never drawn to a straw color and I am sure that neither is troubled with any internal strains.

A smith doing tempering should do no welding and should, when not employed at tool work, be at some kind of work that can always be done at a low heat; then by following the rules laid down here he can become an expert on hollow mills as well as other tools. My equipment and method are as follows:

Fig. 2 shows a hollow mill *A*, mounted on a stud or mandrel *B* which is made of machine steel to fit the mill and

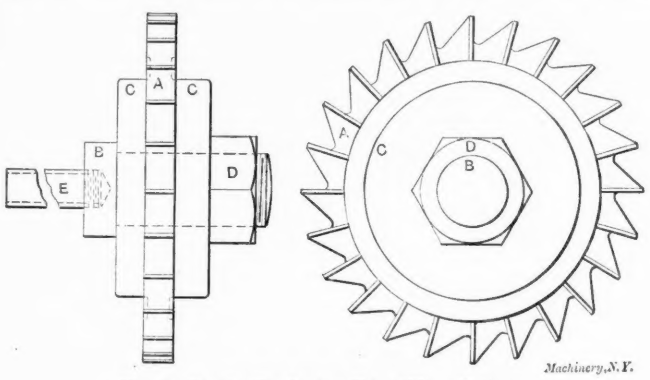


Fig. 3. Rig for Hardening Side Milling Cutters.

provided with a washer *E* and nut *C*. The stud must closely fit in the slot of the hollow mill, as shown at *F*. The end of the stud opposite the threaded end is tapped out with a pipe tap for the pipe handle *D*, which is used for handling the work when heating and hardening, the handle being a half-inch pipe about 24 inches long. This same pipe handle will do for a large variety of different sized studs. Of course if a furnace is provided for heating tools of this kind a pipe handle will not be necessary, but if only an ordinary forge is used for tempering and hardening this scheme is desirable. It is quite necessary to have a good mill file at hand to test the hardness of tools, for sometimes in my experience I have known the toolmakers to send out tools made from machine steel, and insist on having them hardened and tempered. In such cases the file is the only method of showing the toolroom foreman his mistake. I have experienced this trouble more than once and know whereof I speak.

Build a fire in the tempering forge with charcoal lumps about the size of a hen's egg. Place the hollow mill assembled as shown in Fig. 2 on the fire and cover with charcoal; shut off the blast and let the tool heat with the charcoal until it has reached a nice bright heat, then take out, dip into a solution of salt and water in the proportion of about ½ pint of salt to 2 gallons of water. Be sure that the salt is well dissolved. Do not let the milling cutter cool in the water, but when the red is all gone remove from the water, let the tool dry and plunge in a crock of fish-oil. Leave the cutter there until cold enough to handle, then take out, remove the nut and washer, take the cutter off and send it to the toolroom to be put to work. Perhaps the smith will not be successful with the first one hardened and tempered by this method but a few trials will lead to success.

When tempering milling cutters of the type shown in Fig. 3 the smith must have a small, high fire and put on the blast lightly, turning the tool constantly until ready to dip. Then dip in salt water the same as directed for the hollow mill. The result is no warping or cracking and no internal strains in any cutters tempered in this manner, and they will stand more hard work than if tempered in any other way. In explanation of the rig used for tempering the milling cutter shown in Fig. 3, *A* is the cutter, *B* the stud, *C* the washers, *D* the nut, *E* the pipe for handling. The washers protect the body of the cutter from heating and only the teeth are heated to the hardening temperature. The consequence is that there is no necessity for drawing the temper of the body of the cutter inasmuch as it has never been heated to the hardening heat; consequently it is always left soft.

A serious trouble with heating tools to remove internal strains aside from those already mentioned is shown in the case of a solid reamer. Suppose a solid reamer is held over the fire to remove internal strains. The result is that the thin edges which are the cutting parts are heated much quicker than the internal parts, and are softened, so much, perhaps, as to render the tool useless, but by hardening as just directed and taking the reamer out of the water before it is cool and putting it into fish-oil its toughness is preserved and at the same time it does not get any softer than it was when it was removed from the water.

[The method recommended by Mr. Sallows, of course, is radically different from general practice, although strictly analogous to the common practice of hardening and tempering chipping chisels and similar tools. If a milling cutter, hollow mill or any other expensive tool can be successfully hardened on the points of the teeth only we are sure that the practice is one to be recommended for several obvious reasons. If there are serious objections let us hear what they are.—EDITOR.]

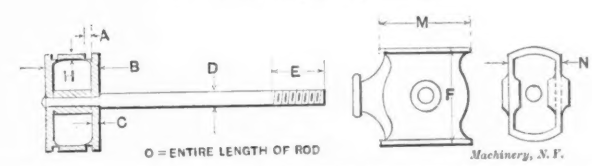
* * *

SLIDE VALVE ENGINE PROPORTIONS.

The accompanying tables on plain slide valve engine proportions, including cylinders, connecting-rods, valves, pistons and piston-rods, crossheads, crankshafts, crankpins, crank-disks and eccentrics, were compiled by Mr. C. R. McGahey, while superintendent of Lombard Iron Works, Augusta, Ga.

PISTON, PISTON-ROD AND CROSSHEAD.

O = entire length of piston-rod.

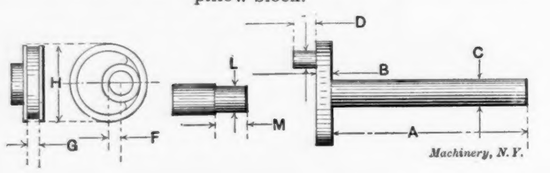


Cylinder.	*A*	*B*	*C*	*D*	*E*	*M*	*N*	*H*	*O*	*F*
7 x 10	⅜	3	⅜	1⅜	3⅝	7¾	4	⅜	23⅝	8
8 x 10	⅜	3	⅜	1⅜	3⅝	7¾	4	⅜	23⅝	8
9 x 12	½	3½	½	1½	5	9½	5	½	28⅝	10
10 x 12	½	3½	½	1½	5	9½	5	½	28⅝	10
11 x 14	⅝	3⅞	½	1¾	5½	10½	5½	½	33	11¼
12 x 14	⅝	3⅞	½	1¾	5½	10½	5½	½	33	11¼

We are assured by Mr. McGahey that the tables of dimensions represent the most advanced and best known practice with this type of steam engine. The tables are of the same order as the dimensions of equal section and concentric piston rings contributed by Mr. McGahey in the February (1906) issue.

ECCENTRIC, CRANKSHAFT AND CRANK-PIN.

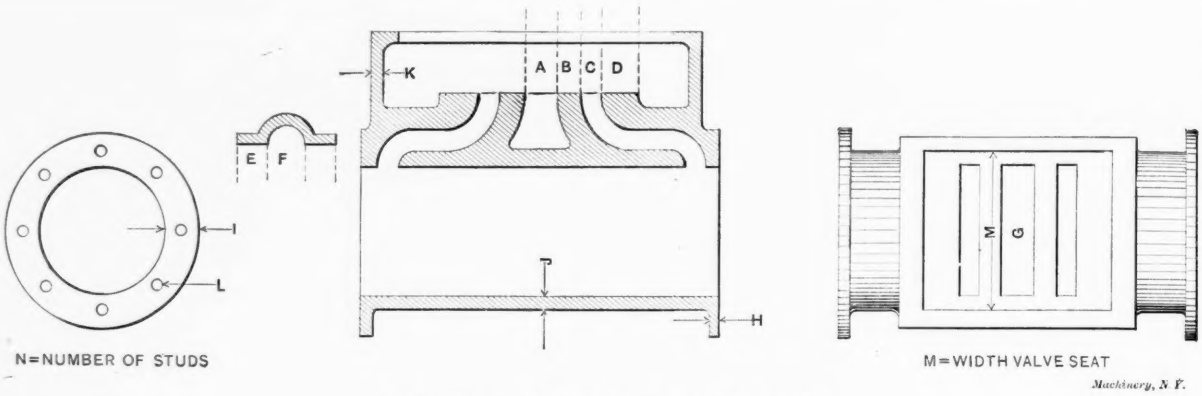
I = travel of valve. J = width main bearing. K = width main bearing pillow block.



Cylinder.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*
7 x 10	42	$2\frac{3}{8}$	$3\frac{3}{8}''$	$2\frac{3}{4}$	$1\frac{15}{16}$	1	$1\frac{1}{4}$	$6\frac{1}{4}$	2	7	$8\frac{3}{4}$	$1\frac{13}{16}$	$2\frac{1}{8}$
8 x 10	42	$2\frac{3}{8}$	$3\frac{3}{8}$	$2\frac{3}{4}$	$1\frac{15}{16}$	1	$1\frac{1}{4}$	$6\frac{1}{4}$	2	7	$8\frac{3}{4}$	$1\frac{13}{16}$	$2\frac{1}{8}$
9 x 12	54	3	$4\frac{3}{8}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{3}{4}$	8	$2\frac{1}{2}$	$8\frac{1}{2}$	10	$2\frac{3}{8}$	$2\frac{7}{8}$
10 x 12	54	3	$4\frac{3}{8}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{3}{4}$	8	$2\frac{1}{2}$	$8\frac{1}{2}$	10	$2\frac{3}{8}$	$2\frac{7}{8}$
11 x 14	57	$3\frac{3}{8}$	$5\frac{3}{8}$	$3\frac{3}{4}$	$2\frac{11}{16}$	$1\frac{3}{8}$	2	$8\frac{1}{2}$	$2\frac{3}{4}$	10	$12\frac{1}{2}$	$2\frac{9}{16}$	$3\frac{1}{8}$
12 x 14	57	$3\frac{3}{8}$	$5\frac{3}{8}$	$3\frac{3}{4}$	$2\frac{11}{16}$	$1\frac{3}{8}$	2	$8\frac{1}{2}$	$2\frac{3}{4}$	10	$12\frac{1}{2}$	$2\frac{9}{16}$	$3\frac{1}{8}$

the cutting edges, which are further apart to insure that the width of the land would be equal in all cases. That this is impracticable when fluting reamers in any large quantities is easily apprehended, as it would necessitate raising or lowering the milling machine table for each flute being cut. In the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, a method is shown employed by the large machine tool firm of Ludwig Loewe & Co., Berlin, Germany. The principle of this method is clearly shown in the accompanying cut. A formed cutter, eccentrically relieved, is employed which, instead of forming only the flutes, forms the actual land of the reamer, thus insuring that every land becomes equally wide with the others. The depth of the flute is determined by the depth of the portion of the cutter in front of the cutting edge of the reamer and it is easily seen that all the flutes will be equally deep.

That this method will be more expensive than the one commonly employed, in which the lands are permitted to become wide or narrow according to the amount the flutes are broken up, is evident, but it cannot be disputed that the general appearance of the reamer will be greatly improved. The greater expense in making reamers in this manner will depend on two factors. In the first place, the eccentrically relieved cutter will cost more to produce than the ordinary fluting cutter. In the second place, the cutting speed cannot be as high with a cutter of this description as it could be with an ordinary milling cutter. On the other hand, it is possible not only to gain the advantages mentioned above in regard to width of land and depth of flute, but incidentally there is also gained the possibility of giving to the flute a more correct form to answer the requirements of strength as well as chip room, which are often by necessity overlooked on account of the straight sides forming the flutes which are necessary to adopt when using the ordinary straight-sided fluting cutter, with milling cutter teeth of the common shape. While it cannot be expected that this method will be used to any great extent on account of its drawbacks from a commercial point of view, it is ingenious and well worth attention.

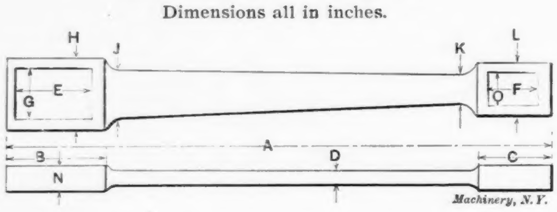


CYLINDER, VALVE AND VALVE SEAT.

Diameter Cylinder.	Length of Stroke.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*
7	10	$1\frac{1}{16}$	$\frac{9}{16}$	$\frac{5}{8}$	$1\frac{1}{8}$	$1\frac{11}{32}$	$1\frac{7}{8}$	$5\frac{7}{8}$	$\frac{7}{8}$	$2\frac{1}{4}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$6\frac{1}{2}$	6
8	10	$1\frac{1}{16}$	$\frac{9}{16}$	$\frac{5}{8}$	$1\frac{1}{8}$	$1\frac{11}{32}$	$1\frac{7}{8}$	$5\frac{7}{8}$	$\frac{7}{8}$	$2\frac{1}{4}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$6\frac{1}{2}$	6
9	12	$1\frac{3}{8}$	$\frac{5}{8}$	$\frac{23}{32}$	$1\frac{7}{32}$	$1\frac{5}{8}$	$2\frac{1}{4}$	$8\frac{3}{4}$	$\frac{7}{8}$	$2\frac{3}{4}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	$8\frac{3}{4}$	8
10	12	$1\frac{3}{8}$	$\frac{5}{8}$	$\frac{23}{32}$	$1\frac{7}{32}$	$1\frac{5}{8}$	$2\frac{1}{4}$	$8\frac{3}{4}$	$\frac{7}{8}$	$2\frac{3}{4}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	$8\frac{3}{4}$	8
11	14	$1\frac{3}{4}$	$\frac{11}{16}$	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{13}{16}$	$2\frac{3}{4}$	$9\frac{5}{8}$	$\frac{15}{16}$	3	$\frac{13}{16}$	$\frac{11}{16}$	$\frac{3}{4}$	$10\frac{3}{8}$	10
12	14	$1\frac{3}{4}$	$\frac{11}{16}$	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{13}{16}$	$2\frac{3}{4}$	$9\frac{5}{8}$	$\frac{15}{16}$	3	$\frac{13}{16}$	$\frac{11}{16}$	$\frac{3}{4}$	$10\frac{3}{8}$	10

FORGED STEEL CONNECTING-ROD.

Dimensions all in inches.

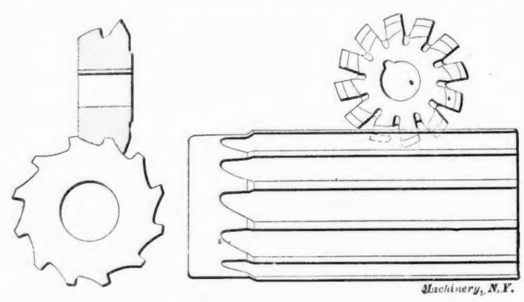


Cylinder.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*J*	*K*	*L*	*N*	*O*
7 x 10	$31\frac{1}{8}$	$6\frac{5}{8}$	$5\frac{1}{8}$	$\frac{3}{4}$	$5\frac{1}{8}$	$3\frac{5}{8}$	$3\frac{1}{8}$	$4\frac{5}{8}$	$3\frac{1}{4}$	3	$1\frac{3}{4}$	$1\frac{3}{8}$	$3\frac{5}{8}$
8 x 10	$31\frac{1}{8}$	$6\frac{5}{8}$	$5\frac{1}{8}$	$\frac{3}{4}$	$5\frac{1}{8}$	$3\frac{5}{8}$	$3\frac{1}{8}$	$4\frac{5}{8}$	$3\frac{1}{4}$	3	$1\frac{3}{4}$	$1\frac{3}{8}$	$3\frac{5}{8}$
9 x 12	$36\frac{3}{4}$	$7\frac{1}{8}$	6	$\frac{7}{8}$	$5\frac{1}{2}$	$4\frac{1}{4}$	$3\frac{3}{8}$	5	4	$3\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{5}{8}$	$4\frac{1}{4}$
10 x 12	$36\frac{3}{4}$	$7\frac{1}{8}$	6	$\frac{7}{8}$	$5\frac{1}{2}$	$4\frac{1}{4}$	$3\frac{3}{8}$	5	4	$3\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{5}{8}$	$4\frac{1}{4}$
11 x 14	43	8	$6\frac{5}{8}$	$1\frac{1}{8}$	$6\frac{1}{4}$	$4\frac{7}{8}$	$3\frac{3}{4}$	$5\frac{1}{2}$	$4\frac{5}{16}$	4	$2\frac{5}{8}$	$1\frac{7}{8}$	$4\frac{7}{8}$
12 x 14	43	8	$6\frac{5}{8}$	$1\frac{1}{8}$	$6\frac{1}{4}$	$4\frac{7}{8}$	$3\frac{3}{4}$	$5\frac{1}{2}$	$4\frac{5}{16}$	4	$2\frac{5}{8}$	$1\frac{7}{8}$	$4\frac{7}{8}$

* * *

NEW METHOD OF MILLING THE FLUTES OF REAMERS.

In milling the flutes of reamers it is customary to mill them so that the cutting edges will not come an equal distance from one another. This prevents chattering and permits the use of an even number of flutes. The difficulties encountered in milling the flutes on unequal distances, or breaking up the flutes as it is commonly termed in the shop, are that if all the grooves are milled to the same depth the remaining land evidently will be wider in the case where the distance from cutting edge to cutting edge is larger than it will be in the case where this distance is smaller. To overcome this it would, of course, be possible to mill the flutes deeper between

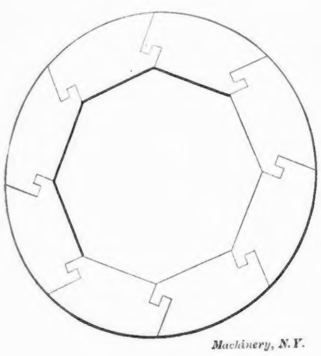


German Method of Fluting Reamers.

ITEMS OF MECHANICAL INTEREST.

WOODEN LOCK-JOINT COLUMN.

The Woodworker illustrates a method of making column joints which, on account of its ingenious interlocking device, may deserve the attention and interest of others than woodworkers. As seen from the cut, the finished column constitutes a solid, which cannot be disintegrated by any other means than by sliding one of the interlocking parts out in a longitudinal direction. Evidently it cannot be assembled in any other way, either, than by sliding in the last section from the end.



Method of Making a Wooden Lock-joint Column.

PAPER MILK BOTTLE.

Here is an item of mechanical interest for this page quite out of the usual run, but it is nevertheless of much general interest. It is a paper milk bottle designed to replace the glass bottles now generally used. The paper bottle is claimed to have the advantages of less cost, much less weight, greater cleanliness, no expense for washing and return transportation. When it is known that the ordinary glass milk bottle weighs as much as the milk, *i. e.*, two pounds for a quart bottle it at once becomes apparent that the bottles represent half the dead weight when milk is transported in this shape. The dead weight loss is still greater in that the bottles have to be returned. The paper bottle is designed to be used only once and then thrown away, thus saving all cost of returned transportation, and also washing. The bottles are made in three sizes, quarts, pints and half-pints, the material used being three-ply spruce wood fiber paper rolled into a frustrum of a cone. The bottoms are secured by an ingenious lock, and it is claimed that the inverted bottle will support a load of 200 pounds without collapse. The lid is an inverted cup fitted into the lumen of the bottle and having a contact with the sides of ½ inch. Removal is facilitated by four tabs which permit of finger hold. The whole bottle including the bottom and top is covered with a coat of paraffine which more or less completely impregnates the paper. The cone shape facilitates packing, as they may be assembled in "nests," putting one inside another and thus saving much space. An idea of the saving of weight may be gained from the fact that 150,000 paper bottles may be shipped in an ordinary freight car, the weight being only about six or eight ounces each as against about thirty-two ounces with glass.

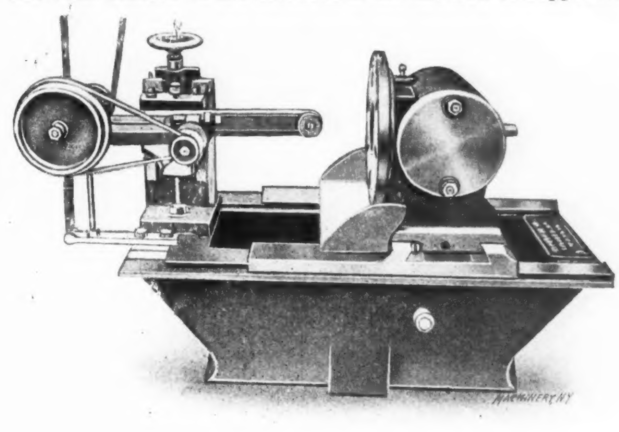
Paper Milk Bottle.

SQUARE HOLE GRINDING MACHINE.

An unusual machine for an unusual operation—the grinding of square holes, as indicated in the title—has been designed and is being put on the market by C. W. Burton, Griffiths & Co., Ludgate Square, Ludgate Hill, London, E. C. The special operation for which the machine is needed is that of finishing square holes in the hardened gears used in automobile speed transmission cases; it is intended to do away with the slow and costly lapping operation which has hitherto been resorted to for truing up these surfaces in getting rid of the distortion resulting from the hardening operation to which they are subjected. It is also applicable to the finishing of dies of various kinds and other hardened parts having internal flat surfaces difficult to reach by ordinary means.

The work is fastened on the faceplate at the right of the machine. This faceplate, which is 12 inches in diameter, is mounted on a spindle having a 4-inch diameter hole to permit gears or pieces with projecting bosses to enter the end of spindle and thus make the clamping more convenient. In the case of the plain machine this faceplate has indexing notches and is provided with a locking lever. A cross slide operated by a screw and hand wheel, graduated to 0.001 inch, gives the necessary adjustments for feeding. This machine is adapted for grinding parallel holes only. The universal machine, in addition to grinding parallel holes, will grind tapered ones, the work carrier having an angular adjustment both above and below the horizontal axis and a circular movement around its base. Where required the machine can be furnished with self-acting travel of the work carriage on the bed at extra cost.

The vital feature of the machine is the method of supporting



Square Hole Grinding Machine.

and driving the emery wheel. This wheel, of small enough diameter to enter the square hole which it is desired to finish, is mounted on a transverse axis at the outer end of the long bar shown. The short spindle which carries the wheel at one end is mounted on ball bearings set as far apart as possible and carries a grooved pulley at the opposite extremity. An endless belt, made from a leather ring rolled until the edges have been rounded, is used to drive this short spindle and the wheel fastened to it. As will be readily understood from the cut, the spindle, emery wheel, belt and bar are all of such proportions that they can enter bodily the hole which is to be finished. In order that the maximum of stiffness may be obtained in the support of the grinding wheel, it is recommended that a separate bar be used for each size of hole, with separate spindle and wheel for each. The price of one bar and its attachments is included with the machine.

A small speed multiplying countershaft is used to transmit the motion from the countershaft belt to the wheel. The bar is carried on a vertical slide adjustable by the handwheel shown. The countershaft is supported by a mounted arm with spring tension so as to prevent vibration in the driving belt from affecting the emery wheel bar as it would be liable to do if attached rigidly to it. This precaution, in addition to the use of an endless belt for driving the wheel spindle, assures the freedom from jar and vibration necessary for accurate work. The vertical adjustment of the slide permits the grinding of flat, broad surfaces greater than the diameter of the wheel. The work is ordinarily traversed by means of a rack and pinion operated by a hand wheel.

* * *

Where any apparatus, such, for example, as a small jib crane, has to be operated by hand power and which requires a considerable exertion of a man or a number of men, the location and throw of the crank become important. Apparently, experience has shown that a height of 32 inches above the ground or platform for the crankshaft and a crank length of about 16 inches (32 inches throw) suits the average laborer best. For light exertion the crank length should be made only about one-half this diameter, or, say, 8 inches, and should be elevated so that the crankshaft is, say, about 40 inches above the floor level.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

FEBRUARY, 1907.

PAID CIRCULATION FOR JANUARY, 1907,—21,936 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

A WORD TO CORRESPONDENTS.

Probably every editor has the trouble of getting letters from correspondents who neglect or avoid giving their names and addresses. It is a generally recognized rule that all such contributions must remain unnoticed. It is, of course, impossible to answer any such inquiries by mail and it is against newspaper ethics to answer them in the reading columns. All correspondents should understand that any confidence reposed by them is inviolate; they need not fear that any one outside the office will discover their identity. Any and all communications should invariably be accompanied by the name and address. If, for any reason, it is desired that these be suppressed, simply mention the fact and it will be done.

Perhaps an apology, or rather an explanation, is due some of our valued correspondents for delays in publishing their communications, especially those which refer to articles already printed. In general we endeavor to use immediately all such which are considered available, but the limitations of space have made it impossible to do so in several instances lately. Hence the belated appearance this month of matters which refer back three or four months. But even under the most advantageous circumstances it is slow work carrying on discussions in the columns of a monthly, a condition which we regret very much as often some of the most valuable contributions are the direct result of discussion. However, we hope no one will be discouraged in making pertinent comment when so moved.

Some of our readers evidently have accepted the catch problem "Old Euclid Disproved at Last" in a very serious way; several letters were received that took "R. S." severely to task for presuming any such heresy. While we were very glad to get these assurances of Euclid's soundness we wish to say mildly that no one of the editors, nor "R. S." himself, expected that the proposition would be taken seriously or in any other way save as an ingenious fallacy.

* * *

THE MANAGEMENT OF AN INDUSTRIAL UNDERTAKING.

The achievements of the late president of the Pennsylvania Railroad in behalf of the transportation system of which he was the head is one more example upon the necessity of placing a practical engineer in this position, if thorough and permanent improvements and progress are the results to be desired. Mr. Cassatt had risen to his position not through manipulations in Wall Street, as so many others have done, but through ability and experience gained through long years of close application to engineering problems. He knew the requirements of a great railroad system from an engineer's point of view, and it is greatly due to the fact that Mr. Cassatt was more of a technical man than a financier that the Pennsylvania railroad system is in the lead in all respects pertaining to the engineering of the road.

This principle holds good in regard to manufacturing establishments no less than in regard to railroads. The factory which is constantly "bossed" by men who are merely men of business, with little or no practical training in the technical part of their responsibility, is liable some day to find itself left behind in the race by the shop where a man, risen from the rank and file, well acquainted with every detail of the economy of production, is placed in authority. It is true that present conditions call for a good business management of every concern which shall hold its own for any length of time. But it is equally true that an undue importance has in many cases been affixed to the business end of an undertaking, and that the technical end has been neglected. At any rate, one hesitates but little to say that things are wrongly proportioned when the man conducting the outside business of a firm is compensated four or five times as liberally as is the man upon whom rests the responsibility of economical production within the shop. If men of technical training more often occupied the authoritative positions of manufacturing plants, we feel inclined to think that the result would be similar to the experience of the railroad mentioned which cannot regret having employed an engineer rather than a Wall street manipulator. The comparison between a railroad and a shop may not be direct, but the difference is one in degree rather than in kind.

* * *

MANUFACTURING AND MUD.

While visiting one of the great engineering establishments of our country a number of years ago, in the midst of a period of damp weather, the writer was sharply impressed with the untidiness and general sloppiness of the streets and grounds about the buildings. His guide was plainly a little sensitive on the subject and felt called upon to offer an apology for the condition. "You see," he said, "we are making extensive additions to our plant, so the streets are all cut up with the heavy teaming, and there is considerable litter about." A few weeks ago the writer again visited the same plant. Great changes had taken place. Many of the old buildings were still there, but they were overshadowed by the lofty, airy, finely planned and equipped steel and concrete structures which had been built since the last visit. Yet, in spite of all this newness, there was something very old and familiar about our painful progress from one building to another. As before, the paths and roadways were almost impassable; here and there a block of wood or a stone projected above the level of the slime, and on these precarious footholds we leaped from point to point like mountain goats. The guide evidently felt called upon to apologize. "You see," he said, "we are making extensive additions to our plant, so the streets are—" etc., etc. Quite possibly the visitor to this plant ten years hence will hear the same old song.

Perhaps the expenditure required for draining and paving the roadways of so extensive a plant would be too great to yield an adequate return, although there is at least room for argument in the matter. Even though the industrial railway is employed entirely for transporting goods from building to building, so that the streets are seldom used for horse-drawn vehicles, the moral effect of the surroundings on the employes ought to count for something. It is noteworthy that the cotton mills of New England, almost without exception, have found it wise to take good care of their buildings, together with the streets and grounds surrounding them; and this condition exists in the face of the fact that the industry is at times carried on with a margin of profit that seems almost dangerously small. We cannot escape the conviction that there is a screw loose somewhere, when care, thought and money are expended in magnificent buildings and elaborate equipment, which, when completed, are only to be reached by a painful journey through deserts of débris and seas of slime.

THE PRINCIPLES OF RATIONAL DESIGN.

When writing the comment in the January issue, on the difference in design in three bevel gear generating machines made by three different firms, each of whom had the same object in view, we were reminded of a conversation held some time ago with a machine tool designer whose name is familiar to the readers of MACHINERY. This designer made the assertion that there is but one design possible to suit a given set of requirements. Curiously enough he took this very case of the generation of the bevel gear as an example and explained with some detail the mental processes which had evolved a machine of this type he had recently developed. In the first place, range and capacity must be determined as the prime limiting requirements. Then the other considerations which enter into the design—the theoretical, constructional and commercial factors which make or mar the success of the machine, must be carefully considered. It was his belief that, with these requirements carefully listed, analyzed and followed, there must in any given case result a definite design—definite, that is, in everything except the most unimportant details. He was, indeed, quite confident that if the memory of this machine were blotted from his mind, upon undertaking the task again, the new lay-out would be practically identical with the first.

When one comes to think about it, is it not true that this procedure represents an ideal to which the designer will more closely approximate as he becomes more skillful? Its antithesis is surely all too common in shops which have not yet emerged from the Egyptian darkness of the days of "cut and try." Under these latter conditions, when a new device is to be worked out, a roughly constructed trial machine is built and set to work. The feed is too slow—it is speeded up; the machine has not enough belt power—the 5-step cone is removed and a 3-step cone substituted; these two handles interfere in certain positions—the controlling mechanism is rearranged to correspond; and so on, the resulting machine giving in its final and "perfected" form plain evidences of the haphazard way in which it was developed. Of course there must always be some factors in the design of a machine which are experimental, especially those which have to do with the commercial success of the device. But the successful designer is he who, from his own experience and from his ability to use the experience of others, can reduce to a minimum the indeterminate factors of the problem. With all these indeterminate factors finally determined in accordance with the state of the art at a given time, the ideal designer would perhaps pursue a train of thought resulting in a machine whose every detail of construction was pre-determined from the moment when he first put pencil to paper.

* * *

CONSIDERATIONS ON THE PERMANENCE OF CONCRETE STRUCTURES.

Those of our readers who are familiar with Boston will remember the Emancipation Statue in Park Square, where the Old Colony depot used to be. A concrete-steel garage, which is being erected here, seems to have aroused considerable interest among the inhabitants of that learned town. There is certainly something which appeals to the imagination in the idea of a monolithic structure, made without joint or seam. A light-hearted *Herald* reporter, referring to the abovementioned building, has thus relieved his mind, paraphrasing the words of Napoleon's famous speech before the Pyramids of Ghizeh: "Fire cannot touch it, it can never wear out, all the king's horses and all the king's men could not budge it. Some day Mr. Lincoln will say to the bronze darkey: 'Rastus, from yon reinforced-portland-cement-concrete-steel automobile-garage forty centuries look down upon you.'"

There is, however, a serious side to this concrete-steel question, if the new material is anywhere nearly as permanent as we are led to believe. Europeans have long scoffed at the ephemeral character of our structures and the condition of perpetual change which is characteristic of our great cities. This condition, which now bids fair to be modified at least, has nevertheless been our salvation so far as the architectural beauty of our buildings and their fitness for their purpose is concerned; there is scarcely a building over twenty years old devoted to business in New York City, whose destruction would draw a tear from any eye for other than financial reasons. But now that we are beginning to build in this new material for future generations, it becomes the solemn duty of the designers and owners of each new structure of any importance to question themselves earnestly as to whether the design possesses enough grace of form and fitness for its purpose, to make it acceptable to our great grandchildren's children. In structures designed for purely mechanical uses, with dimensions mathematically determined, there usually exists a simplicity and appropriateness which is in itself a near approach to beauty. In the case of other structures, however, it would seem as if the interests of the public were almost of sufficient importance to require the approval of the plans by a building commission, not only from the standpoint of safety, as is now done, but from artistic considerations as well.

* * *

KNOWING THE REASON "WHY."

When Charles B. Dudley said that the technical graduate who knows the reason "Why" will in a short time in practical life distance his fellow student who simply had covered a certain amount of ground and stored up a large array of facts, he struck the true keynote of success in the field of engineering. And this is true not only of technical graduates. It is equally true of any man in any station in life. The man who simply knows that certain things are so, without knowing the reason "Why," without having grasped the underlying principles, will find little use for his knowledge. The ability of application of principles is the secret of the success of most designers of machinery, and far more of men engaged in structural or civil engineering. It is very seldom that identically the same conditions reappear in the problems to be solved in either case. The machine designer, for instance, except in the case of machines which have nearly become standardized, meets with new conditions in every new machine he plans. The mere knowledge, however, complete and intimate as it may be, of the construction of another machine helps him but little. But the principles applied are nearly always the same. If he knows why certain transmissions of motion work better in one case, and others in another, if he knows why the heaviest strain on the parts necessarily must come in this direction and not in that, why the method of oiling which was very superior in one case would be a failure if applied to the conditions in hand, and so forth, if he knows why all these things are as stated, then he is far better equipped for the design of an efficient machine than if he had studied machine design for years as a matter of memory as is often done in technical schools.

This is the reason why so often men who have had no particular technical training but long practical experience are so often promoted to positions where the design of machines is either directly or indirectly their duty. It is not their practical training itself which fits them for these places. There are plenty of cases where men of little or no actual shop training have reached the highest efficiency in machine designing. It is because practical shop work usually teaches a man the reason "Why." The man who has no desire to learn the reason why, may work like an automaton at his machine in the shop for a dozen years and know less of the principles governing his work than does the apprentice with a mechanical and inquisitive mind after six months.

The technical school which teaches its students the reason "Why" rather than a great mass of facts, is the school that will in the end gain the best reputation. The principles of engineering can be taught, but their application is easier learned by actually doing, performing, than from text-books. The technical graduate who is equipped with a thorough understanding of the reason "Why" is the one possessed of the greatest asset for life, no matter what be the actual amount of formulas and rules crammed into his head. And the young man, whether he be a technical graduate or not, who is desirous of fully understanding what little he knows, rather than to know a great deal which he does not understand, he is the one who, other things being equal, will succeed.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A new method of producing stronger iron castings, known as the Doherty process, injects a small quantity of dry steam into the cupola with the air blast. It is claimed that the resulting castings are 25 per cent stronger, and that they are cleaner and easier to machine than when produced without the steam blast.

A 3⅛-inch rock drill, at full work, has been found to require 28 to 32 indicated horsepower at the compressor, but the actual power used against the rock was determined in a certain case to be only 1.7 horsepower. On the basis of 28 horsepower at the compressor, consequently, the efficiency of power at the drill bit was only 6 per cent.—*Scientific American.*

Experiments made in Germany by Messrs. Erdmann and Köthner of Charlottenburg indicate that a substance having the characteristics of cork may be made by the action of acetylene on copper in the presence of heat. As yet, however, the product lacks the strength necessary for it to be a complete substitute for cork, and the probabilities are that it can never be made so.

The Societé Alsacienne d'Electricité, of Strasburg, Germany, has constructed an indicator for extremely high speeds, according to designs prepared by the inventors, Messrs. Hospitalier and Charpertier. The usual apparatus is replaced by a photographic arrangement by means of which a negative is produced instead of the usual pencil card. The instrument has been successfully used at speeds of 2,000 revolutions per minute.—*Railway Review.*

As a result of the practical tests which have been in operation in Sweden, with a view to electrifying the whole of the railway system of the country, the government is building at the Falls of Gullspang a large electricity station capable of producing not less than 150,000 H.P. According to the calculation of experts, it is expected to result in reducing by $400,000 annually the consumption of British coal.—*The Mechanical World.*

The statistics of cars and locomotives ordered in 1906, as compiled by the *Railway Age* (December 28, 1906), show that in 1906 5,642 locomotives, 3,402 passenger cars and 310,805 freight cars were ordered by the various railway companies. The number of locomotives and freight cars ordered show a falling off from the number ordered in 1905, being respectively 6,265 and 341,315. The number of passenger cars ordered in 1905 was 3,289.

The earliest search for iron on the Vermillion Range and in Minnesota was in the vicinity of Tower and Soudan in 1861, but, because of the lack of transportation facilities, no development was possible until the present Duluth and Iron Range Railway, chartered in 1874, was completed in 1888 and the actual opening up of the district was accomplished. At the present time ore is being taken from a single shaft on which 300 men are employed, where formerly there were thirteen shafts operated and 1,800 men were employed at one time. The season's shipment for the Soudan mine is stated to be approximately 225,000 tons of ore.

Tin-foil, which is extensively used for wrapping tobacco, certain food products, and other articles of commerce, is a combination of lead with a thin coating of tin on each side. According to the *Valve World* it is made in the following manner: First, a tin pipe is made of a thickness proportionate to its diameter; proportion not given. This pipe is then filled with molten lead and rolled or beaten to the extreme thinness required. In this process the tin coating spreads simultaneously with the spreading of the lead core and continuously maintains a thin, even coating of tin on each side of the center sheet of lead, even though it may be reduced to a thickness of 0.001 inch or less.

It is reported that Dunwoodie & Jackson, Glasgow, Scotland, have introduced producer gas plant as a substitute for gasoline engines, which, it is claimed, secures a considerable saving. The apparatus has been used on a 3½-H.P. Star automobile and a 30-H.P. industrial vehicle with satisfactory results. Either coke or charcoal may be employed, and it is stated that a 30-H.P. vehicle can be run for one hour on 19½ pounds of coke and 2 gallons of water. This represents an outlay for fuel of 6 cents per hour. The engine to which the apparatus is attached can be started from the cold in five minutes. The plant consists of a producer, fuel hopper, blower to supply air, small pump for feed water, gas cooler and air mixing valves and water tanks. The weight of a plant for a 40-H.P. car is stated to be less than 250 pounds.—*Horseless Age.*

A chimney 506 feet high will be built at the Boston & Montana smelter, Great Falls, Mont., to carry off the gases from the smelting furnaces; it will be the highest chimney in the world, as the highest at the present time is 460 feet, a chimney at Freiburg, Germany. The stack is designed to have an inside diameter at top of 50 feet, and an outside diameter at bottom of 75 feet. The location of the structure is 3,535 feet above sea level. The chimney top will be 742 feet above the charging floor of the furnaces. The Alphons Custodis Chimney Construction Co., of New York, N. Y., which has the contract for building the chimney, is putting up a brickyard near the site, for making the perforated radial brick of which the main shell will consist. The construction of the chimney is estimated to take a year's time, and will cost about $200,000, exclusive of the foundation. The total weight of the structure approximates 16,600 tons.—*Engineering News.*

A simplified method for transforming readings of the Fahrenheit thermometer into Centigrade values and *vice versa* is given in the *Naturwissenschaftliche Rundschau.* The ordinary formula:

$$C = \frac{5}{9}(F-32),$$

where C is the number of degrees in Celsius or the Centigrade system and F in Fahrenheit's, is not adapted for very rapid calculation. This formula, however, may be written:

$$C = \left(\frac{1}{2} + \left\{\frac{1}{2}\times\frac{1}{10}\right\} \times \left\{\frac{1}{2}\times\frac{1}{100}\right\} + \ldots\right)(F-32)$$

The three first terms in the series in the first parenthesis are usually near enough for any ordinary conversion. To transform, for example, 88 degrees F. we have $88 - 32 = 56$, and

$$28 + 2.8 + 0.3 = 31.1,$$

which calculation can easily be performed.

Shipments of iron ore from the important deposits in the north of Sweden to foreign countries are restricted by government regulation. In view of the favorable condition of the iron market the mining company had secured leave to ship 400,000 tons additional in 1906 and 600,000 tons additional this year. The stipulated quantity is 1,200,000 tons a year and an increase of 300,000 tons for this year had already been granted. In view of the fact that these natural deposits are in no way indebted for their existence to the present individual exploiters, but may be regarded as a gift of nature to the whole nation, and to coming generations as well as to the present, such government restriction is in no way out of place. In other respects than this the Swedish people have taken care of the interest of the future generation. Being one of the greatest lumber-producing countries in Europe the supply of lumber would gradually diminish if provisions were not made for the annual replanting of the forests. For this reason the laws of the country provide that a certain per cent of the area covered with forests shall be replanted yearly.

The Seamless Tube Company of America, which is affiliated with the Pittsburg Steel Company and whose works are situated at Monessen, Pa., has recently purchased four 300-horsepower Allis-Chalmers compound wound, non-reversible direct-current motors. Speed variation will be obtained by means of shunt field regulation and each motor will be furnished with a starting panel, including an automatic circuit breaker and switch. One motor will be connected by gears to a 20-inch two-high mill for rolling tubes. One will be direct-connected to a mill for piercing steel billets, and two will be connected by gearing to cold drawbenches for cold drawing tubes. The invasion of steel works and rolling mills by electric power has been revolutionary. It is doubtful if ten years ago the most sanguine friends of this means of power transmission would have predicted the common adoption in so short a space of time of electric power for driving heavy rolling mills. The line of improvement in this class of machinery which has done more than any other to encourage its adoption in mill operation has been that of developing a high torque at starting. Thus far the use of electricity has reached no limit in iron and steel works operation, and its more recent success, in driving the heaviest rolling mill, leaves apparently little that cannot be conquered.

We have received a little booklet from the Decimal Association, 605 Salisbury House, London, England, giving Lord Kelvin's views on the advantages of the metric system and the opinions of several other eminent Englishmen, etc. The arguments are pro-metric and about what might be expected from scientists not intimately acquainted with the practical difficulties of introducing the metric system into manufacturing plants where the English system is established. A suggestion for the convenience of translation of metric and English units is worthy of notice, although it only applies where no great accuracy is required. It would apply to the rougher measurements, such as are required for railway rails, structural steel girders and other material of construction. These may be translated from the English measurements of inches, quarters, eighths, sixteenths, etc., to millimeters with a discrepancy amounting to 1-128 in one inch, as follows:

By taking 1 inch = 25.6 millimeters in place of 25.4 millimeters,

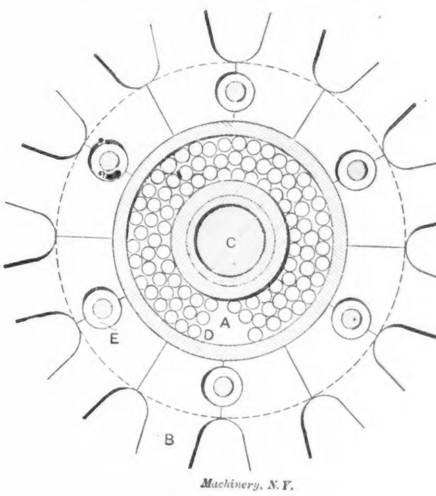
then 1-2 inch = 12.8 millimeters.
1-4 inch = 6.4 millimeters.
1-8 inch = 3.2 millimeters.
1-16 inch = 1.6 millimeters.
1-32 inch = 0.8 millimeter.
1-64 inch = 0.4 millimeter.
1-128 inch = 0.2 millimeter.

Two great engineering schemes are at present under consideration in England. The first one is the revived proposition of connecting England and France by a tunnel under the English Channel. Although a bill has been deposited in Parliament for the incorporation of the Channel Tunnel Company there is room for doubt whether the scheme will ever be carried out. Admitted that it is feasible from an engineering point of view, would the tunnel be able, for instance, to successfully compete with large railway ferries, if such were installed to ply between Dover and Calais? However, we congratulate those in authority for having finally decided that there are no military objections to the tunnel, as it has been always claimed that the tunnel would offer a great opportunity for an invading army. How that can be, we on this side find hard to understand. The most desirable position in which we, for instance, could place an invading army seems to be in one of the tubes under the Hudson river. But then, we are only laymen in military matters.

The other great engineering undertaking to be financed in England but to be carried out in South Africa is the transmission of power by means of electricity from the Victoria Falls to Rand, a distance of about 700 miles. The original proposition provides for a transmission of 50,000 H. P., but it is intended to increase this to 150,000 H. P. While this seems an enormous undertaking, there seems to be greater feasibility as well as usefulness in this latter proposition than in the tunnel scheme.

SHOCK-ABSORBING HUB FOR MOTOR CARS.

The Practical Engineer shows a new type of wheel hub devised to prevent destructive vibrations from being transmitted to the body of the vehicle from the axle. The hub, called the shock-shifting hub, is filled with steel balls loosely packed, which support the axle. The weight of the axle, carrying the vehicle, automatically forms the vacant space *A* as shown in the cut, and this space is constantly maintained when the wheel is in motion. Any shock to the wheel from the road may be considered as traveling up a spoke situated



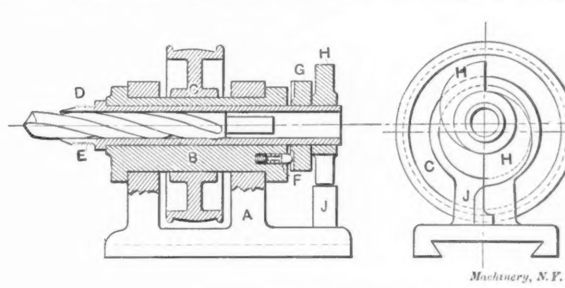
Shock-absorbing Hub.

as *B* and the ordinary course of such a shock is direct to the center of the axle *C*. Owing, however, to the mobile condition of the balls resting on one another and always ready to slip over each other, revolving on their own axes, a row of balls beneath the axle (marked *D* in the diagram) is immediately displaced. These balls are forced across the vacant space *A* and, followed by other balls, cause the shock to pass into the ball chamber in the backward moving half of the wheel. The road shock is thus broken up in its transmission, almost absorbed, and prevented from ever reaching the axle. It is claimed that the movement of the car is extremely steady, because there is no reactionary shock on the wheel such as invariably must result where springs are utilized or even where rubber alone in any form is applied to lessen the vibration.

AUTOMATIC DRILL GRINDER.

Zeitschrift für Werkzeugmaschinen und Werkzeuge, Nov. 15, 1906.

The cut illustrates a device which is the subject of a recent German pattern for grinding twist drills. Only the headstock of the machine is here shown. To the headstock frame *A*, which is slowly fed along the bed of the machine toward a grinding wheel placed at a suitable angle to it, is journaled the revolving bushing *B* driven by a continuously rotating



Automatic Drill Grinder.

pulley *C*. The bushing *B* is bored eccentrically to carry drill holding bushing *D*, which may be changed to suit the diameter of the drill being ground. A threaded cap acting on the tapered and split end of this sleeve serves to hold the drill firmly. *D* is free to revolve in *B* except for the restraining action of spring plunger *F*, which seats in either of the two shallow grooves milled opposite each other on the inner face of collar *G* as shown. Collar *G* is fast to sleeve *D* and revolves with it. Attached also to *D* is the double-winged stop

cam *H* whose radial faces are adapted to engage with the fixed stop *J* on to the headstock casting.

The operation of the mechanism as just described is as follows: With the parts in the position shown and pulley *C* rotating in the right-hand direction, stop cam *H* is in position to be free from stop *J*, so that *C*, *B*, and sleeve *D*, with the contained drill, revolve as one piece under the influence of plunger *F* seated in the groove in the face of collar *G*. This revolution of the drill about an eccentric axis past the angular face of the wheel grinds the end of it in a form to give suitable clearance to the cutting edge. At the end of half a revolution from the position shown, the upper leaf of stop cam *H* has been brought around in contact with stop *J* which arrests the motion of *G*, *D*, and the work. Continued movement on pulley *C* and sleeve *B* raises the drill, carrying its axis in a semi-circular path without, however, rotating it. This path carries the cutting edge treated away from the face of the grinding wheel. Plunger *F* was of course unseated from the groove in collar *F* as soon as stop cam *H* came in contact with *J*. At the completion of the second half revolution, however, the parts are again in the position shown in the cut, except that the plunger *F* has dropped into the other groove in its opposing collar and the other lip of the drill is ready to be sharpened. The process is thus a continuous one and only the gradual feeding forward of headstock *A* toward the wheel is needed to give a suitable form to the cutting edges of the drill.

[This device is very interesting as an example of the ingenious accomplishment of a somewhat complicated operation with very simple means, but in the matter of building a practical machine upon the principle here illustrated, we are in some doubt. The adjustments that would be required to fit the device to drills of different sizes would be so cumbersome as to apparently limit the usefulness of the scheme.—EDITOR.]

HARDENING STEEL BY ELECTRICITY.

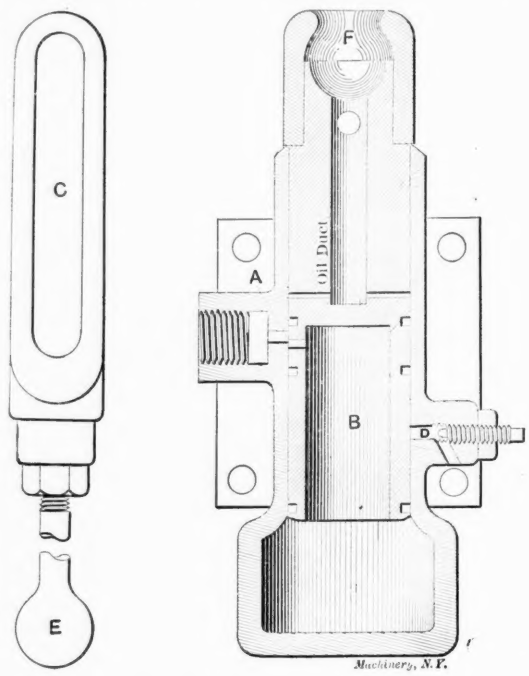
There are about sixty different methods of hardening steel, each of which has its advocates, and no one of which is suited for all sizes and shapes of articles, or for all kinds of steel. One way which has not yet come into general use is hardening by electricity, and is described by Garnier in the *Genie Civil*. The process is simple and the appliances necessary neither complicated nor costly; neither is any great amount of previous experience in this particular manner of hardening required. The tool to be hardened is put in electric connection with the positive pole of the battery or other source of current; in similar connection with the negative pole there is a cast-iron tank full of carbonate of potash dissolved in water. The current is regulated by a rheostat. The tool is plunged to the desired depth in the solution, just as for hardening in the usual maner; the current is then switched on and the tool heated to the same degree as would be required in ordinary hardening. When the proper temperature has been reached and held for the desired time, the current is switched off and the tool left in the bath, which latter, by the simple act of switching off the current, is at once converted into a hardening bath.

Another method, which permits of hardening places on the surface of pieces, where the dipping process would not accomplish the desired object, is local heating with the electric arc. Here the tool or other article is laid on a copper block, and an ordinary arc carbon held in a safety holder; the electric connections with holder and block being made, the carbon pole is touched to the piece to be locally hardened. Of course the heating is both intense and local; the work-piece is at once plunged in the ordinary hardening bath, and when one place is hardened the next may be heated, and so on. The electric current may also be used to draw the temper of a hollow object. Instead of using a red-hot iron rod to plunge in the bore, a cold rod is employed, which is used as a resistance in the circuit of a secondary current of about two volts tension. The temperature of the iron rod gradually rises, and when the work-piece has reached the desired color, the current is shut off. This method is said to produce less liability to cracking than the old-fashioned way of drawing the temper with a hot rod. It is particularly recommended for large hollow mills. The great advantage consists in the perfect regulation possible by means of a rheostat, and in the possibility of getting exactly the same temperature every time for similar objects, once the right heat and color are attained.

R. G.

SIMPLE LOCOMOTIVE BELL RINGER.

The *Railway Master Mechanic* illustrates and describes a simple locomotive bell ringer, which is operated by compressed air. The special features of advantage of the device are its durability, simplicity of construction, and minimum air consumption. The mode of operation is as follows: Air entering at port *A* starts the piston *B* upward, which movement promptly closes the inlet port, the expansion of the air completing the stroke of the piston. When the bottom of the piston reaches port *D*, enough air exhausts to allow the weight of the bell to force the piston down, closing the exhaust and compressing the air in the chamber, which compression, with a slight addition of air at intake keeps the bell in motion



Simplified Locomotive Bell Ringer.

with the least consumption of air. It will be noted that there are no valves, packing rings or oil cups required, as oiling the ball bearing lubricates the piston through a small oil hole shown in the cut. At *C* the bell crank yoke is shown with its adjustable connecting rod and ball, the latter fitting in the socket *F*.

THE POULSEN SELECTIVE SYSTEM OF WIRELESS TELEGRAPHY.

A new system of wireless telegraphy that gives considerable promise of solving the extremely difficult problem of selectivity, i.e., the transmission and reception of a number of messages in the same field of force simultaneously and without interference, has been devised and tried out by Valdemar Poulsen, the well-known inventor of the telegraphone. Ever since 1897, when Sir Oliver Lodge applied to wireless telegraph transmitters and receptors the combination of open and closed circuits, and introduced the methods of tuning the circuits at either station individually and syntonizing them collectively, have persistent efforts been made by physicists and others to secure a suitable degree of resonance by providing the proper values of inductance, capacity, and resistance, and when these conditions prevailed, it was concluded the receiving resonator system would respond to a specific radiating oscillator system and to this one only.

These efforts seem to have met with a measurable degree of success in the case of Poulsen's system, which differs greatly in principle from that of Marconi, the former making use of what is termed undamped electric waves. The difference between these waves and those employed in Marconi's system is not easy to explain to one who is not an electrical expert; but using sound waves as an analogy the difference

may be roughly illustrated by comparing the electric waves used in Marconi and similar system to the violent agitation caused by a pistol shot, and Poulsen's undamped electric waves to the continuous vibration of a tuning fork, and just as a pistol shot will cause all the strings in a piano to vibrate and a tuning fork only the particular string giving the same note, so undamped electric waves exercise a selective influence of much greater delicacy than the violent discharge used in the present systems. One great advantage promised for the new waves is the possibility of tuning them and varying their length and amplitude so greatly that multiplex telegraphy may be carried on without the risks of interference to which present systems are so liable. Many attempts have been made to solve the problem of producing undamped electric waves of a sufficient high frequency and energy for practical purposes, and Poulsen's success is attributed to his having ascertained the peculiar properties manifested by an electric arc when immersed in an atmosphere composed of or containing hydrogen, whereby he has been able to obtain a million or more vibrations per second.

It is stated that a dozen messages have been transmitted and received between as many experimental sets by means of this new selective system without interference; and if this extraordinary result can be duplicated over distances of 50 or 100 miles, as the experiments thus far made between the inventor's two Danish stations indicate, an advance will have been made that, in its importance, will be second only to the introduction of wireless telegraphy itself.

THE INFLUENCE OF TEMPERATURE ON THE FRAGILITY OF METALS.

M G. Charpy, in Memoirs de la Societe des Ingeniurs Civils. Paris, October, 1906.

This paper deals with the determination of the liability of steel to break from shock, as affected by the temperature. The results obtained show such a marked change in the rigidity of the specimens at different temperatures as to indicate that the question is one of greater importance than generally considered. After reviewing briefly the work done by other experimenters, the author describes the preparation of the test pieces employed in his investigation. Five large ingots were

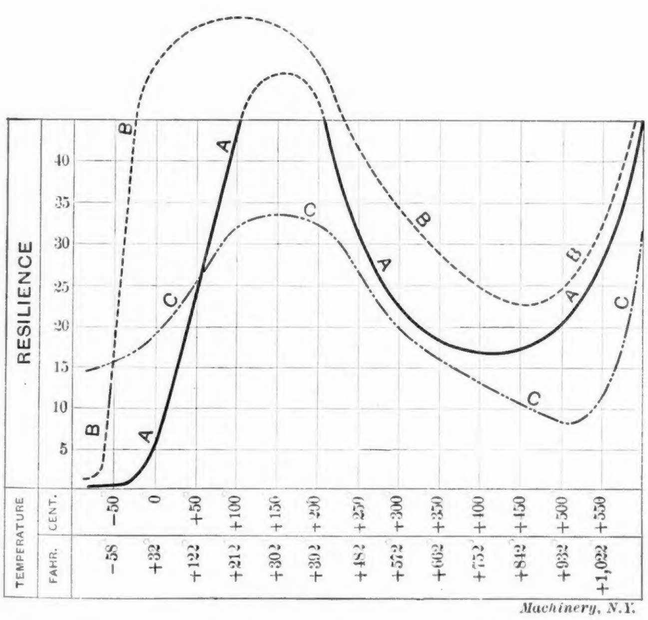


Fig. 1. Variations of Fragility with Temperature in Mild Steel.

prepared having the following characteristics: Ingot A, an extra mild steel of the quality generally obtained by the Thomas process; *B* a very pure mild steel made in the Martin furnace; *C* a semi-mild steel made in the Martin furnace and submitted during the solidification of the metal to compression by wire drawing in accordance with the Harmet process; *D* a semi-hard steel containing a little nickel, made in the Martin furnace; *E*, a Chrome-nickel steel made in the Martin furnace. The following table gives the composition of these different steels.

COMPOSITION OF STEELS USED IN TESTS.

	C	*Mn*	*Cr*	*Ni*	*S*	*P*
A	0.04	0.33	....	....	0.02	0.05
B	0.14	0.28	....	....	0.006	0.005
C	0.21	0.60	...	...	0.03	0.03
D	0.36	0.34	....	1.10	0.01	0.01
E	0.36	0.37	1.60	3.50	0.005	0.02

From each of the large ingots (which were carefully worked) smaller test pieces were cut about 30 millimeters square and 160 millimeters long. Both by microscopic examination and by testing of specimens taken from widely separated portions of the ingot, care was taken to insure that the quality of metal should be practically the same throughout. The tests made to determine this showed that the end had been practically accomplished. The test pieces were all submitted to a prolonged temperature of about 900 degrees Centigrade to remove internal strains so far as possible, and all

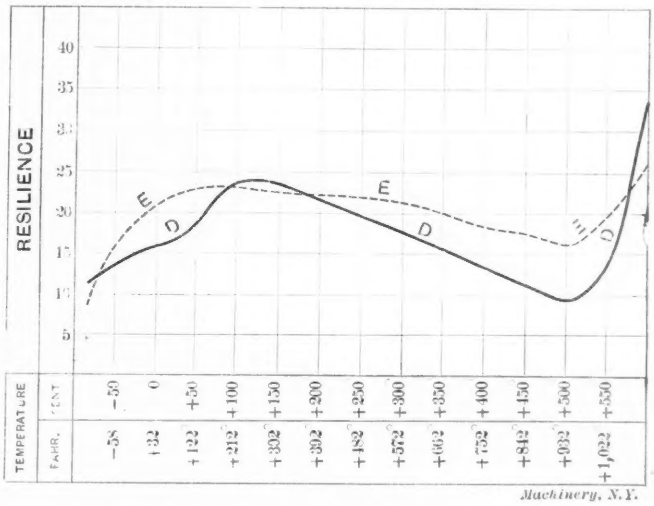


Fig. 2. Variations of Fragility with Temperature in Chrcme and Nickel Stee's.

the bars of each metal were given an individual tempering treatment to give to each the minimum amount of fragility possible.

In testing these specimens the bars were notched to a depth of 15 millimeters, the bottom of the notch having a radius of 4 millimeters. They were then tested in a pendulum hammer machine, of usual type. Here they were subjected to a series of rapid blows, each of which had a definite intensity in foot pounds or kilogrammeters. The number of blows received by the specimens before fracture is thus a measure of the resilience of that small section of the material exposed in cross section at the notched portion.

The bars were placed in a bath maintained at the temperature desired for the experiments in hand, this bath being of ether or of acetone for low temperatures, of water or oil for medium temperatures, and of chlorides or melted alkaline azotates for high temperatures. Each specimen was seized with the tongs and placed on the supports of the testing machine, where it was submitted to the shock. The time that elapsed between the taking of it from the bath and the breaking was always well within ten seconds, so one can be sure that the variation of temperature was negligible. The following temperatures were experimented with: —80 degrees, —18 degrees, +6 degrees, +30 degrees, +97 degrees, +200 degrees, +290 degrees, +350 degrees, +425 degrees, +500 degrees, +600 degrees. Two specimens of each metal were tested at each temperature.

The results are graphically represented in the curves of Figs. 1 and 2. It will be seen that for all the steels tried, the resilience (which varies inversely with the fragility) increases as the temperature is raised until the maximum of between 100 and 200 degrees is obtained, then it diminishes, attaining a minimum of between 400 and 500 degrees, representing the fragility at the blue color; then it is again raised as the temperature increases until the red heat is attained. The variations are, above all, important for the mild metals.

It is striking to note that for metal A the variation in passing from +20 degrees to —20 degrees lowers the resilience in the ratio of 6 to 1. Metal B, which is of a similar kind but much more pure, likewise undergoes enormous variations, though they are less important from a practical standpoint. It is nevertheless remarkable that this metal which is able after suitable thermal treatment to bend back on itself in the notched section at the ordinary temperature, breaks like glass at a temperature of —80 degrees, absorbing an amount of work scarcely measurable, and becoming at that point much more fragile than the metals of Fig. 2.

The special semi-mild steels appear to present a great superiority from the point of view of the influence of temperature on fragility. Metal E of chrome and nickel steel, which offers a resistance to breakage by tension of about 80 kilograms, possesses at ordinary temperature a resilience of about 16 kilogrammeters, which descends to only about 14 kilogrammeters when cooled to a temperature of —80 degrees.

The practical conclusions which are to be drawn from this experiment are then: First, that by the employment of special steels (of the Chrome-nickel order) the dangers of the variation of the fragility by change of temperature can be almost entirely avoided, even those relating to the fragility at a blue heat. Second, that the increase of fragility at low temperatures should be taken into serious consideration in the case of mild steels, above all when these steels are mediocre as regards their purity, for under such circumstances their increase of fragility is sufficiently rapid and of sufficient intensity to give rise to severe accidents.

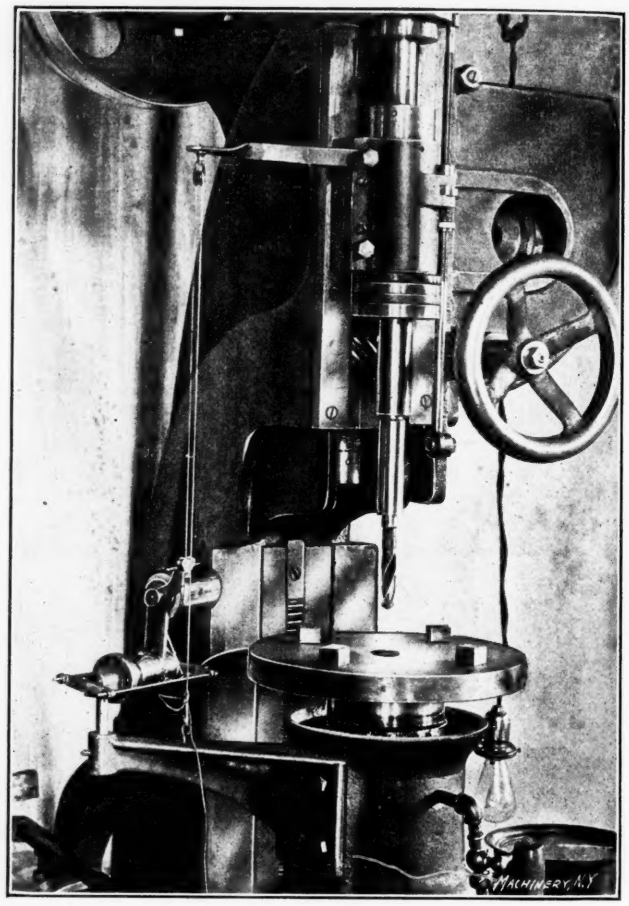
TEST OF TWIST DRILLS AT WORCESTER POLYTECHNIC INSTITUTE.

Journal Worcester Polytechnic Institute.

Some recent experiments of great interest to toolmakers and machine builders have been made with high-speed drills at the Worcester Polytechnic Institute. To carry out these tests a special machine was designed and built, being exceptionally strong and heavy, it having been found that the thrust necessary to push a drill through a piece of metal was very much greater than is generally supposed. An ordinary drill press did not permit the drills to be used up to their full capacity. The most important parts of the machine built are shown in the cut below. The range of feeds obtainable vary from 0.0045 to 0.0225 per revolution of the spindle. The dynamometer for registering the thrust and twisting moment of the twist drill when tested was very simple and efficient. A hollow piston with a round top to form a table was scraped to fit a cast-iron cylinder. The cylinder was filled with heavy cylinder oil and had an ordinary pressure gage tapped into the lower end. The gage gave the reading in pounds per square inch and in order to get the thrust of the drill it was necessary to multiply by the area of the piston which was about 20 square inches. To measure the twisting moment a steel band fastened to the enlarged top of the piston was connected to an indicator spring by means of a steel rod screwed into the bottom of the indicator piston. Since the area of the indicator piston was only ½ square inch, and the force was applied direct, the indicator spring had to be rated at ½ of the value it would have when used in a steam indicator. The movement of the drum of the indicator was obtained by passing a cord over a pulley which was attached to the carriage of the spindle and then fastening the end to a projecting arm of the dynamometer. Taking the average force as registered by the indicator diagram and multiplying by the radius of the round table gave the twisting moment. In none of the tests did the moment exceed 350 inch pounds which was obtained with a ⅞-inch drill running at a speed of 328 revolutions per minute, and a feed of 0.0225 inch per revolution. This was the largest size drill with which tests were undertaken.

It had, previous to these tests, been found that there was a great variation of the thrusts obtained from drills of the same diameter working under the same conditions. This depends upon the fact that the thickness of the web of the drill varies quite widely for the same diameter of the drill even on tools manufactured by the same maker. Mr. Fairfield of the Worcester Polytechnic Institute has deduced from common practice the law that beginning with a drill of 0 diameter and estimating a thickness of web equal to 1/64th inch the thickness of the web should increase 1/64th for every increase of ⅛ inch in diameter of the drill. Expressing this in a formula: If D be the diameter of the drill, and W the thickness of the web, we would have $W = \frac{D}{8} + \frac{1}{64}$. All the drills used in the test had as far as possible a thickness of web corresponding to this formula. The drills were made of Novo steel and the test pieces were of cast iron of as uniform composition as possible.

Of the results of the tests, those which will mostly interest toolmakers are those referring to the angle of the lip of the drill. As is well-known manufactured drills have a constant angle of the lip of 59 degrees. Several tests made with a ⅝-inch drill, varying the angle of the lip from 37½ degrees to 70 degrees, show that the 59-degree angle is not the most desirable one. In fact, the tests show that with different angles



Machine Arranged for Twist Drill Tests.

of lip the thrust decreases from 70 degrees down to 45 degrees and then increases for any further decrease in angle. The twisting moment, however, does not seem to stand in any relation whatever to the angle of the lip but is very nearly proportional to the feed of the drill. From this it would appear that a 45-degree angle ought to give the best results in practical machine shop work. According to the *Journal Worcester Polytechnic Institute* there is only one instance in which the 45-degree angle is given the preference over the common angle of 59 degrees, and that is the case of the Wm. Sellers Co., Philadelphia, Pa.

RAILWAY MOTOR CARS.

There has of late been a great increase in the use of self-contained motor cars for passenger service on European railroads, and there has been a marked advance in the same direction in this country in cases where the railroads have found themselves called upon to handle a large suburban traffic. It is therefore of interest to note a review of the best use of such cars presented to the (British) Institution of Mechanical Engineers as reported in *The Engineering Magazine.*

The best method of conveying passengers, clearly, is that one which yields the best results in the balance sheet, and at the same time gives satisfaction in other ways. The opinion held by most locomotive engineers, and by a large number of electrical engineers, on the broad and general question of railway electrification, is that for close suburban traffic only is it justifiable. It is suggested and maintained that the electrification of branch and main line traffic will, as a general rule, result in a loss to the railway company, as the load-factor at the power-station will be a very poor one, owing to the intermittent traffic. On the other hand, suburban traffic, especially if in thickly populated areas, calls for a more frequent service and a greater acceleration of speed than is attainable with ordinary passenger trains. It is obviously impracticable to use ordinary trains to meet the demands of a frequent service, on account of the cost, the running expenses and the capital outlay being too great in proportion to the number of passengers. Turning then to the question of self-contained cars, comes the necessity for deciding the type of motive power. For such a service electricity is naturally considered, and in some cases the conditions are such that electric traction is manifestly superior. The railroad man, however, must look to the commercial side of the question, and a close examination of the subject shows that lines where the service is necessarily light and intermittent, and where the distances to be run are several miles, the power house would need to be large in proportion to the average work done; and where heavy gradients have to be worked, the peak load would be large in proportion to the average and minimum, and rapidly fluctuating therefrom. The necessarily large units which would have to be provided in the generating station to meet this maximum motor power and high peak load, would be costly, and consequently the capital outlay would be out of proportion to the work done.

For these reasons English railroads have found, after careful investigations and calculations, that the electrification of steam railroads for suburban service is not the most economical or preferable course, but that the introduction of self-contained steam cars is by far superior from the financial point of view. In regard to the comfort of the passengers, however, one would be inclined to look more favorably upon the electric cars.

Disregarding the motive power the advantages of self-contained cars are plainly in evidence, and these are put forth as follows: Owing to the small unit, a much more frequent service is given with a better percentage of load to dead weight hauled, while the mileage cost of working is only about one-third the cost of an ordinary passenger train-mile. The facility of picking up and setting down passengers at line crossings, small villages, etc., makes the service more popular, and enables many passengers to travel who would not otherwise be able to. The rapid rate of acceleration makes the through speed higher. The experience of those railways who have given both an extensive trial is that the system is equally advantageous for heavy and sparse traffic. In the first case the motors sandwiched in between the regular trains find a traffic without taking it away from the trains, while in the second the traffic has been developed by the more frequent service. The number of steam-cars at present running proves their utility, and it seems certain that in them railways have the best, and in fact the only, effective answer to street-car competition.

THE FIRST MACHINE FOR THE COMMERCIAL PRODUCTION OF WINDOW GLASS BY THE SHEET PROCESS.

Scientific American, December 1, 1906.

The manufacture of window glass is one of the few arts which seem to have resisted all the efforts of the keenest mechanical intellects to raise it from the station of a handicraft which involves much costly and cumbersome human labor, to the dignity of an automatic process. The hand-blown cylinder method by which the bulk of window glass is made at the present time is not merely very simple, but almost primitive even in its crudeness. The process, which is almost too well known to require description, consists briefly in blowing a large mass of plastic material to the shape of a cylinder of uniform diameter and thickness, open at each end. It is then cut open, rolled out flat, heated and annealed. The only successful method which has been made to improve on this process was the introduction of machinery for drawing and blowing cylinders, and window glass to-day is made largely by this means, although it is not considered an important advance in the art.

By far the most systematic and painstaking study which has been made of the whole problem we owe to Mr. Irving W. Colburn of Franklin, Pa. He has attacked it on every conceivable side, expended large sums in experimenting, built and destroyed machine after machine, and, after eight years, has produced the first commercially successful apparatus for drawing sheet glass of any reasonable width, thickness, surface and polish, desired. After a long series of failures along the more obvious lines of passing plastic glass through heated rollers (a process impracticable on account of the marking of the surface produced) and after a long series of failures in other directions, he gave up the direct solution of the problem for a time and devoted his energies to the manufacture of window glass by the cylinder process, which he succeeded in improving to a marked degree. Efficient as his improvements were, however, they fell far short of what would be expected of a machine which would be able to draw glass from the furnace in continuous sheets. Aside from the fact that the slightest touch of a roller on the surface of the sheet marked it to a degree that rendered it useless for window purposes, the greatest difficulty in this was that, like all plastic substances, the glass as it is drawn from the reservoir of molten material, tends to contract more and more as the tractive pressure is maintained.

To prevent this Mr. Colburn hit upon the method illustrated in Fig. 1. In this plan spheres of fireclay are em-

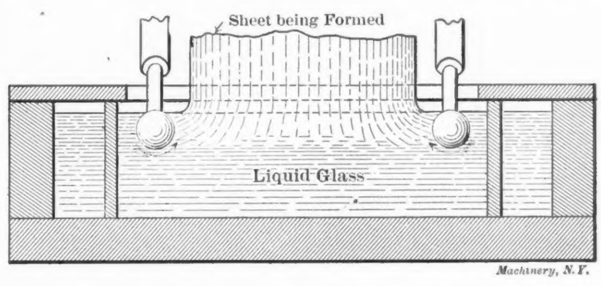


Fig. 1. Method for Preserving Width of Sheet in First Machine.

ployed, carried on the ends of long arms which are immersed in the glass and which are made to revolve upwardly and outwardly, and away from the two edges of the sheet. These spheres impart an outward motion to that portion of the surface of the molten mass lying adjacent to the edges of the sheet, thereby counteracting that tendency to shrink and draw to a thread which is the property of all such materials. By this means he was enabled to draw continuously sheet glass of any desired width and of a thickness varying at the will of the operator from 1-16 to 1-4 of an inch.

Complete success was not, however, immediate. Ribs or wave-like lines or striæ were formed upon the surface of the finished product in some unaccountable way. An elaborate study of the conditions which caused these formations was now undertaken. After observations and experiments extending over a year, it was discovered that the defect was due to several causes, among which was the tendency of the glass to receive on its surface impressions from the rough side walls of the pot, particularly if the point at which the glass left the walls was only a few inches from the point at which the glass entered the sheet. Moreover, the chilling influence of the atmosphere on the surface of the glass, while molten in the working chamber, caused it to lie dormant in spots and also to wrinkle slightly. These defects were hardly perceptible to the eye, but existed nevertheless, and were bound to cause the disastrous wave lines when the glass entered the sheet form.

Mr. Colburn found that by placing near and on each side of the sheet a rotating fireclay cylinder D, slightly immersed in the molten mass (Fig. 2), and at the same time superheating remote portions of the glass, the difficulties were overcome. These rollers are rotated in opposite directions during the operation of drawing the sheet of glass, and serve not only

to impart movement to a portion of the surface of the molten mass away from the edges of the sheet during the drawing operation, but also to determine the area of the surface in the working chamber or pot, which is more or less exposed to the cooling influences of the atmosphere, the superheating occurring on that portion of the surface of the molten mass to the rear of the rollers. These rollers make but one revolution in from ten to thirty minutes, depending upon existing conditions, and serve also as a most perfect equalizer of temperature of the molten glass in the working chamber, which is an absolutely necessary factor in drawing an even thickness of sheet glass. A film of plastic glass adheres to these rollers and is carried upward and over the rollers, chilling slightly in the chamber *A*, because of the presence of the water jackets *C C*, which are inserted, one on each side of the emerging sheet of glass. These jackets are not designed to chill or thicken the sheet, but merely to screen off the heat radiating from the revolving white-hot clay rolls. The plastic film of glass on the rollers melts off entirely in the superheating chambers *B B*.

As the sheet of glass is drawn from the mass of glass lying between the rollers, and as the spheres impart an outward movement to that portion of the surface of the mass lying immediately adjacent to the edges of the sheet, the following effects are observed: The molten glass at and just beneath the surface adjacent to the edges of the sheet moves outwardly and away from the central line of the sheet, thus serving to hold the sheet to its full width. As the sheet moves upward

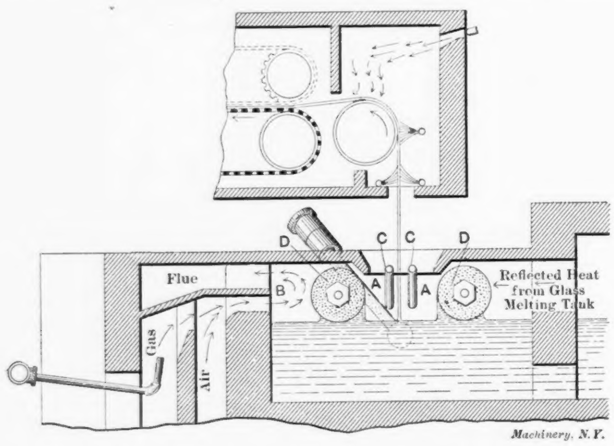


Fig. 2. Cross-section of Perfected Continuous Sheet Machine.

there is drawn into it some of the surface portion of the molten mass immediately adjacent to its two faces, and also some of the molten glass beneath the surface. The skin or surface portion of the glass in the working chamber adjacent to the sides of the sheet being drawn, becomes the skin or surface of the finished drawn sheet. Simultaneously the two rollers on opposite sides of the sheet of glass skim some of the surface portion of the molten glass lying between the rollers and the sheet of glass away from the sheet. The result of the combined action of the drawing of the sheet and the movement of the rollers is a constant skimming of the molten glass lying between the two rollers, so that a fresh portion or a new surface is constantly being exposed to the cooling effect of the atmosphere, which has not time to form wave lines on its surface before it has passed into the drawn sheet or over the revolving rollers. Furthermore, the rollers serve to bring a supply of fresh and uniformly heated molten glass into the area lying between the rollers and the sheet. The glass which is skimmed from the surface by the rollers and carried over them is subjected to the superheating action in the chambers *B B*, as already explained, and is melted down so as to free the rollers from the adhering film, and restore the film itself to a proper working condition. Simple as the expedient of the rollers may seem, it meant months of painstaking observation and experimenting before they were conceived.

Operated by three shifts of men, of eight hours each, three men to a shift (one man filling in the batch to the continuous glass-melting tank furnace, one man watching the operation of the sheet-drawing apparatus, and one man cutting off the glass into sheets and removing them as the sheet emerges from the end of the annealing leer) this machine will produce sheet glass continuously, month in and month out, twenty-four hours a day, stopping only for repairs. The glass leaves the machine at an approximate rate of from fourteen to twenty-eight inches a minute (depending upon whether thick or thin glass is being drawn), and uniform quality of glass is maintained regardless of the speed at which the glass is drawn. Glass much thicker than the heaviest double-strength window glass, as well as the single-strength, can be produced with perfect ease, the quality being midway between the best hand-blown and plate glass. The surface presents a most beautiful fire polish.

After the sheet has been formed it passes from a vertical to a horizontal travel over an idler or bending roller into an annealing leer, which bending roller receives the power necessary to start and keep it in motion from frictional power mechanism acting in conjunction with the frictional contact of the traveling sheet of glass. This combined application of power to the bending roller prevents it from marking or scratching the finished sheet. The glass is rendered sufficiently flexible at the bending point by a series of gas flames, as illustrated in Fig. 2.

* * *

ON THE ART OF CUTTING METALS.—2.*

FRED. W TAYLOR

ACTION OF TOOL AND ITS WEAR IN CUTTING METALS.†

The Action of the Nose of the Tool.

In Figs. 1, 2 and 3 is illustrated in enlarged views the action of a tool in cutting a chip or shaving from a forging at its proper normal cutting speed. It may be said in the case of all "roughing cuts" that the chip is torn away from the forging rather than removed by the action which we term cutting. The familiar action of cutting, as exemplified by an axe or knife removing a chip from a piece of wood, for instance, consists in forcing a sharp wedge (*i. e.*, one whose flanks form an acute angle) into the substance to be cut. Both flanks of the wedge press constantly upon the wood, one flank bearing against the main body of the piece, while the other forces or wedges the chip or shaving away.

While a metal cutting tool looks like a wedge, its cutting edge being formed by the intersection of the "lip surface" and "clearance surface" or flank of the tool, its action is far different from that of the wedge. Only one surface of a metal cutting tool, the lip surface, ever presses against the metal. The clearance surface, as its name implies, is never allowed to touch the forging. Thus "cutting" with a metal cutting tool consists in pressing, tearing or shearing the metal away with the lip surface of the "wedge" only under pressure, while in the case of the axe and other kinds of cutting, both wedge surfaces are constantly under pressure.

After the cut has once been started, and the full thickness of the shaving is being removed, the action of the tool may be described as that of tearing the chip away from the body of the forging and then shearing it up into separate sections; the portion of the chip which has just been torn away, and which is still pressing upon the lip surface of the tool, acting as a lever by which the following portion of the chip is torn away from the main body of the metal.

It may be of interest to analyze to a certain extent the nature of the forces to which a chip and the forging from which it is being removed are subjected through the tearing action of the tool. The enlarged view of the chip, tool and forging, shown in Fig. 1, represents with fair accuracy the relative proportions which the shaving cut from a forging of mild steel (say, 60,000 pounds tensile strength and 33 per cent stretch) finally assumes with relation to the original thickness of the layer of metal which the tool is about to remove.

* Abstract of paper presented before the American Society of Mechanical Engineers, December, 1906.

† As the purpose of these abstracts is to give the results of experiments that will be of direct value in the shop rather than to give a complete record of the experiments themselves—interesting though they are—we have of necessity left out much interesting and valuable matter. The limits of space do not permit the alternative of giving the paper complete. Copies of the complete paper can be obtained from the secretary of the American Society of Mechanical Engineers, 29 West 39th Street, New York. Price, $1.00.—EDITOR.

It is, of course, impossible to accurately determine the extent to which various parts of the chip and forging close to the tool are under compression and tension, but in general the theory advanced is believed to be correct.

Referring to Fig. 1, the forging being cut and the nose of the tool which is removing the chip are shown on an enlarged scale. The thickness of the layer of metal about to be removed is indicated by L between the dotted line and the full line which represents the outside of the forging. It will be observed that the chip is in process of being torn apart and broken up into three sections: Section 1, which is adjoining the forging; section 2, which comes next to it, and in which rupture or cleavage has started and proceeded a little way up from the bottom of the chip and on the left hand side, the shearing action having progressed as far as T_2; section 3, in which shearing has progressed about two-thirds of the way to the top of the chip and is taking place at T_3. Section 4 has been entirely sheared from its adjoining section, and has already left the lip surface of the tool.

On examination of the proportions of the chip it will be noticed that the width of the sections into which the chip breaks up is at their base about double the thickness of the original layer of metal which is to be removed, and that their upper portions are not enlarged to the same extent. These

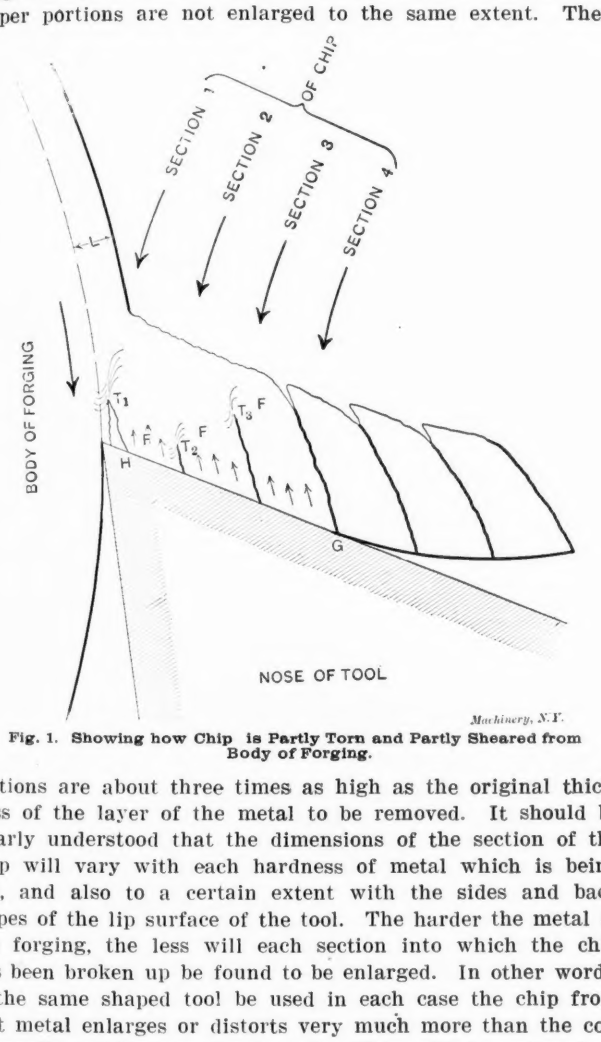


Fig. 1. Showing how Chip is Partly Torn and Partly Sheared from Body of Forging.

sections are about three times as high as the original thickness of the layer of the metal to be removed. It should be clearly understood that the dimensions of the section of the chip will vary with each hardness of metal which is being cut, and also to a certain extent with the sides and back slopes of the lip surface of the tool. The harder the metal of the forging, the less will each section into which the chip has been broken up be found to be enlarged. In other words, if the same shaped tool be used in each case the chip from soft metal enlarges or distorts very much more than the corresponding chip from hard steel. This will be referred to later, in explaining the reason why the total pressure on the tool has but little relation on the one hand to the cutting speed, and on the other hand to the hardness of the metal which is being cut.

The chip bears on the surface of the forging, say, from point H to point G, and throughout this distance is under constant compression from the lip surface of the tool. This compression is transmitted through each of the sections 1 and 2 of the chip, in the direction indicated by the small arrows, to the upper portions of these sections, which are still unbroken and act like a lever attached to the upper part of section 1 to to tear section 1 away from the body of the forging, as indicated at point T_1. The tearing away of section 1 is also assisted by the pressure of the tool upon its lower surface.

After this tearing action has started, the further breaking of the chip into independent sections would seem to be that of simple shearing. It should be borne in mind that in shearing a thick piece of steel the whole piece is not shorn or cut apart at the same instant, but the line at which rupture or cleavage takes place progresses from one surface of the piece down through the metal until within a short distance from the other surface, when the whole remaining section rather suddenly gives way.

In shearing steel, the metal at the point of rupture is pulled apart under a tensile strain, although on each side of the shearing line the metal is under heavy compression.

As each of the sections of the chip successively comes in contact with the lip of the tool, its lower surface is crushed, and the metal flows and spreads out laterally until it becomes about twice its original thickness. As in all shearing, when the full capacity for flowing of the metal has been reached, it tears apart under tensile strain from the body of the adjoining metal of the forging. The compression on the chip from the tool still continues, however, and the chips continue to flow and spread out sideways at a part higher up; *i. e.*, farther away from the surface of the tool, at the portions marked F. In the same way shearing continually takes place at the left side of the portion of the chip which is flowing or spreading out sideways.

There is no question that shearing takes place constantly along the left-hand edges of two of the sections of the chip at the same time, and it is probable that this action occurs most of the time along three lines of cleavage.

Dr. Nicolson's dynamometer experiments show that the pressure of the chip on the tool in cutting a chip of uniform section varies with wavelike regularity, and that the smallest pressure of the chip is not less than two-thirds of the greatest pressure. From this it is evident that shearing must be taking place along at least two lines of cleavage at the same time; since if each of the sections into which the chip is divided were completely broken off before the tool began to break off the following section, it is evident that there would be times when there was almost no pressure from the chip on the tool.

It is at first difficult to see how it is possible for the chip to be shearing at two or three places at the same time. It should be noted, however, that above the points T_1 T_2 T_3 the metal of the chip is still a solid part of the forging, and moves down at the same speed as the forging in a single mass, or body, toward the lip surface of the tool; and with sufficient force to cause each of the three sections of the chip to flow or spread out at the parts indicated by the three letters F. According to the laws which govern shearing, rupture or cleavage in each case must take place as soon as the maximum possibility for flowing has been reached, and in each case shearing must occur at the left of the zone where the metal is flowing.

It is probable that after the shearing action has progressed in section 3 to about the point indicated by T_3, the whole of this section gives way or shears with a rather sudden yielding of the metal from T_3, to the upper surface of the chip. It is this rather sudden shearing point which undoubtedly causes the wavelike diminution in the pressure of the chip indicated in Dr. Nicolson's experiments.*

Action of Cutting Edge of Tool is that of Scraping. Cutting Edge not under Heavy Pressure.

It would appear that the chip is torn off from the forging at a point appreciably above the cutting edge of the tool and this tearing action leaves the forging in all cases more or less jagged or irregular at the exact spot where the chip is pulled away from the forging, as shown to the left of T_1. An instant later the line of the cutting edge, or more correctly speaking, the portion of the lip surface immediately adjoining the cutting edge, comes in contact with these slight irregularities left on the forging owing to the tearing action, and shears these lumps off, so as to leave the receding flank of the forging comparatively smooth.

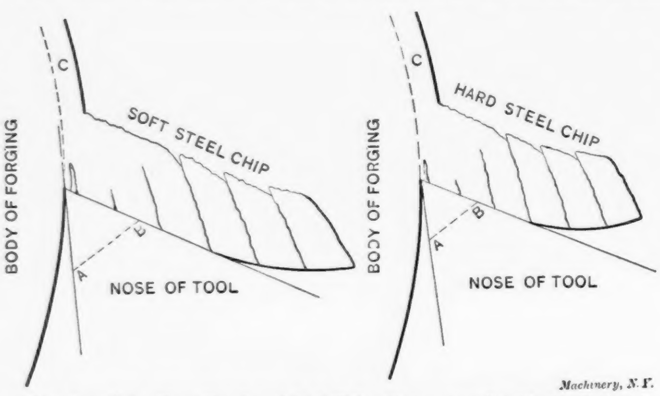
Thus in this tearing action, particularly in the case of cutting a thick shaving, while the cutting edge of the tool is

* Manchester Municipal School of Technology, 1902 and 1903.

continually in action, scraping or shearing off or rubbing away these small irregularities left on the forging, yet that portion of the lip surface close to the cutting edge constantly receives much less pressure from the chip than the same surface receives at a slight distance away from the cutting edge. This allows the tool to run at higher cutting speeds than would be possible if the cutting edge received the same pressure as does the lip surface close to it.

There are many phenomena which indicate this tearing action of the tool. For example, it is an everyday occurrence to see cutting tools which have been running close to their maximum speeds and which have been under cut for a considerable length of time, guttered out at a little distance back of the cutting edge, as shown in Fig. 8. The wear in this spot indicates that the pressure of the chip has been most severe at a little distance back from the edge.

Still another manner in which in many cases the tearing action of the tool is indicated is illustrated in Fig. 4, in which a small mass of metal is shown to be stuck fast to the lip surface of the tool after it has completed its work and been removed from the lathe. When broken off, however, and carefully examined, this mass will be found to consist of a great number of small particles which have been cut or scraped off of the forging, as above described, by the cutting edge of the tool. They are then pressed down into a dense little pile of compacted particles of steel or dust stuck together and to the lip surface of the tool almost as if they had been welded. In the case of the modern high speed tools, when this little mass of dust or particles is removed from



Figs. 2 and 3. How Hard and Soft Chips Bear upon the Lip Surface of Tool. The Soft Chip covers a Much Larger Area of the Lip Surface.

the upper surface of the tool, the cutting edge will in most cases be found to be about as sharp as ever, and the lip surface adjacent to it when closely examined will show in many cases the scratches left by the emery wheel from the original grinding of the tool.

With roughing tools made from old-fashioned tempered steel, however, and which have been speeded close to their "standard speeds," in most cases after removing this "dust pile" from the lip surface, the cutting edge of the tool will be found to be distinctly rounded over. And in cases where the tool has been cutting a very thick shaving, the edge will be very greatly rounded over, as shown in the enlarged view of the nose of a tool in Fig. 9.

Nature of Wear on Tools Depends upon whether it has been Chiefly Caused by Heat.

The appearance of tools which are worn down so as to require regrinding differs widely according to whether or not the heat produced by the pressure of the chip has been the chief cause of wear; and according to the part which heat has played in producing the wear, worn out tools may properly be divided into three classes.

The First Class.—Tools in which the heat, produced by the pressure of the chip, has been so slight as to have had no softening effect upon the surface of the tool.

The Second Class.—Tools in which the heat only slightly softens the surface of the tool during the greater part of the time that it is cutting, while during the latter part of the time heat is the chief cause of wear because, as described in the third class, it greatly softens the lip surface under pressure of the chip.

The Third Class.—Tools in which the heat has been so great as to soften the lip surface of the tool beneath the chip almost at once after starting the cut, and in which, therefore, heat has played the principal part in the wear of the tool.

In the first class, in which heat plays no part in the wear of tools, all tools (whether made from carbon tempered steel, or from the old style self-hardening steel, or from the modern treated tools) wear in about the same manner. Namely, the lip surface just back of the cutting edge is slowly rubbed or worn or ground down through the friction of the chip, as shown in Fig. 7.

As the surface of the tool through the long rubbing of the chip becomes slightly roughened, the tool wears away somewhat more rapidly, but the increase in the rapidity of wear is in this case by no means marked.

On the other hand, tools which wear according to the third class begin to distinctly deteriorate within from one to three minutes after the chip has started to cut, depending upon the length of time required for the friction of the chip to raise the tool from its normal cold state to the high temperature which corresponds to the combination of pressure and speed which produces the heat. And the moment the nose of the tool has reached a degree of heat at which the metal under the chip becomes distinctly soft, the wear then proceeds with great rapidity. Sometimes after arriving at a certain degree of softness, the heat remains approximately constant, and the wear upon the tool continues at a uniformly rapid rate until a comparatively deep groove or gutter has been worn into the lip surface. At other times after the lip surface of the tool begins to soften, it appears to become rougher and cause a still greater amount of friction and heat, in which case the wear of the tool proceeds at an increasingly rapid rate, and the tool is soon destroyed. There are rare instances in which after the rapid wear has started, the friction between the chip and the tool, for some unaccountable reason, appears to become less and the tool slightly cools down. Cases have come under the observation of the writer in which tools which had been running with their noses at a visible dark red heat, cooled off to such an extent that the chip which had been very dark blue in color changed to a color but slightly darker than a brown. This indicated a very marked diminution in friction, although the cutting speed was maintained at a uniform rate throughout. This case, however, is of rare occurrence.

While a deep groove worn by the chip is a characteristic of wear of the third class, by no means all of the tools in this class wear into a deep groove. Most of them give out before the groove has had time to wear deep. After wear of the third class has started, tools will generally be completely ruined in a time varying from 20 seconds to 15 minutes, and the time which elapses between the softening of the lip surface and the final ruining of the tool is exceedingly irregular. One of two tools—which have been proved through standardization to be uniform within, say, 1 to 2 per cent, may give out within one minute after this action starts, while the other may last 15 minutes. On the other hand, occasional lots of tools are found which, after having been proved uniform through standardization, will last under this softening speed for approximately the same length of time.

Reason for Adopting a Standard Test Period of Twenty Minutes.

It is this irregularity in the ruining time of tools belonging to the third class which has led us to adopt a trial period of 20 minutes as being the *shortest ruining time* from which it is safe to draw any correct scientific conclusions from tests in the art of cutting metals.

A cutting speed which causes the tool to be ruined in a shorter period than 20 minutes is accompanied by such a high degree of heat as to produce irregularity in the ruining time; on the other hand, a speed which ruins at the end of 20 minutes is accompanied by that degree of heat at which tools, generally speaking, can be depended upon to wear uniformly. In other words, it represents the degree of heat at which a lot of uniform tools will all give out at about the same time.

Economical Cutting Speeds.

Cutting speeds which are sufficiently slow to cause the tool to wear as described in the first class are entirely too slow

for economy. On the other hand, tools when run at the high cutting speeds which produce wear of the third class last so short a time that these high speeds are entirely out of the question for daily shop use.

It is then with cutting speeds causing wear of the second class that we are chiefly concerned; as it is within this range of cutting speeds that almost all roughing tools in every day use should be run for maximum all-round economy. Cutting speeds of this class are referred to as "economical speeds" or "most economical speeds." Our experiments, therefore, have been practically confined to a study of cutting speeds of the second class.

A cutting speed which will cause a given tool to be ruined at the end of 80 minutes is about 20 per cent slower than the cutting speed of the same tool if it were to last 20 minutes. On the whole, we have concluded it is *not* economical to run roughing tools at a cutting speed so slow as to cause them to *last for more than one and one-half hours* without being reground.

Some of the Characteristic Points of Difference in the Wear of Carbon Steel Tempered Tools and Tools Made from Old-fashioned Self-hardening Steel as Compared with High-speed Steel.

With carbon steel tempered tools at standard speeds the cutting edge begins to be injured almost as soon as the tool

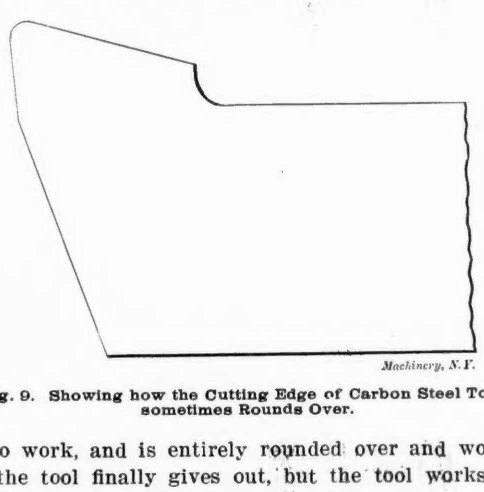


Fig. 9. Showing how the Cutting Edge of Carbon Steel Tools sometimes Rounds Over.

starts to work, and is entirely rounded over and worn away before the tool finally gives out, but the tool works well in spite of its cutting edge being damaged. While with high-speed tools at standard speeds, the cutting edge remains in almost perfect condition until just before the tool gives out, when even a very slight damage at one spot on the cutting edge will usually cause the tool to be ruined in a few revolutions.

Carbon tempered tools and also, to a considerable extent, the old-fashioned self-hardening tools (such as Mushet), when run at their "economical" or "standard" speeds, pass through the following characteristic phases as they progress toward the point at which they are finally ruined: "Rounding of the cutting edge," "mounting of the steel upon the lip," and the "rubbing away beneath the cutting edge"; but it will be understood of course that all progress simultaneously, although each of these phenomena may be separately considered.

Long before the tool is ruined the fine particles of steel or dust scraped off by the cutting edge begin to weld or stick to the lip of the tool and mount upon it sometimes from 1/16 inch to ¼ inch in height, as shown in Fig. 4.

Fig 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

As stated above, in the case of modern high-speed tools, the damage caused to the tool through the action of cutting is confined almost entirely to the lip surface of the tool. Doubtless also the metal right at the cutting edge of the tool remains harder than it is directly under the center of pressure of the chip, because the cutting edge is next to and constantly rubs against the cold body of the forging, and is materially cooled by this contact.

Whether the lip surface be ground away at high speeds or at slower speeds, the nose of the tool is generally "ruined" in a very short time after the cutting edge has been so damaged that it fails to scrape off smoothly even at one small spot the rough projections which have been left on the body of the forging by tearing away the chip. The moment the body of the forging begins to rub against the clearance flank of one of these high-speed tools at or just below the cutting edge, even at one small place, the friction at this point generates so high a heat as to soften the tool very rapidly. After a comparatively few revolutions, the cutting edge and flank of the tool beneath it will be completely rubbed and melted away, as shown in Fig. 5. A tool which was still in "fair" condition when removed from the lathe although showing some slight signs of ruining is shown in Fig. 6.

The above characteristic of holding their cutting edges in practically perfect condition while running at economical speeds up to the ruining point is a valuable property of the high-speed tools, since it insures a good finish, and the maintenance throughout the cut of the proper size of the work, without the constant watchfulness required on the part of the operator in the case of old slow-speed tools with their rounded and otherwise injured cutting edges, which when run at economical speeds were likely at any minute to damage the finish of the work. But when one of these high-speed tools is nearing its ruining point, a very trifling nick or break in the line of the cutting edge will be at once noticed by its making a very small but continuous scratch, projecting ridge, or bright streak, on the flank of the forging, that is, upon that part of the forging from which the spiral line of the chip has just been removed, thus warning the operator of the impending breakdown of the tool.

STRENGTH OF BOILER JOINTS.

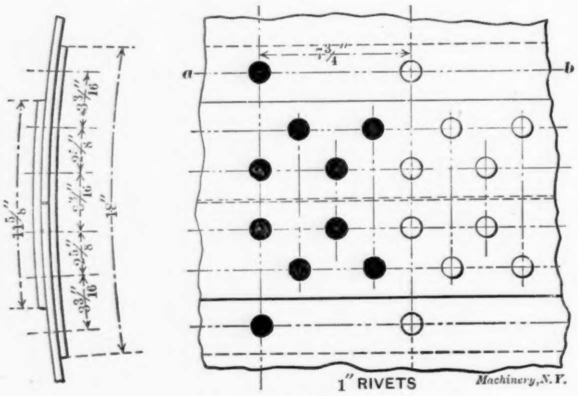
L. A. A.

The calculation of the strength of a boiler is not a difficult operation. The main question is that of the boiler seams. The maximum working pressure is generally the first thing known or given. The inner diameter of largest course is easily found, or is determined by the amount of steam needed. Now we will need to measure, or obtain, the thickness of boiler plate to be used. Let the pressure be given as 200 pounds per square inch, and the radius as 29 inches. The tensile strength of boiler plate varies considerably and can only be known accurately by trial of test pieces. In the case we are to work out let us assume 55,000 pounds per square inch for good steel plate. A suitable factor of safety to assume at the outset, is 6, when figuring on solid plate which has not been weakened by rivet holes. Using the well established formula,

$$\frac{\text{Tensile strength}}{\text{Factor}} \times \text{thickness} = \text{pressure} \times \text{radius}$$

or $\frac{f_t}{F} \times t = PR$, that is,

$$t = \frac{P \times R \times F}{f_t} = \frac{200 \times 29 \times 6}{55{,}000} = 0.632.$$



Triple-riveted Butt Joint.

With these values we will have a ⅝-inch plate. Let us take for example, a boiler having the seam shown in the cut, which is a triple riveted butt joint for ⅝-inch plate (a longitudinal joint recommended by the Hartford Steam Boiler Inspection and Insurance Co.).

Inside radius of largest course in shell $= R =$ 29 inches.

Maximum boiler pressure $= P =$ 200 pounds.

Thickness of boiler shell $= t =$ ⅝ inch.

Diameter of driven rivets—(same as rivet holes) $= d =$ 1 1/16 inch.

Area of rivet holes $= A$.

Pitch of outer row of rivets in seam $= p =$ 7¾ inches.

Number of rivet shears in length of seam "p" $= n =$ 9.

Tensile strength of plate $= f_t =$ 55,000 pounds per sq. in.

Shearing strength of rivets $= f_s =$ 38,000 pounds per sq. in.

First, we will find the *efficiency* of the seam for tearing, that is, the strength of plate left when rivet holes are taken out of distance "p," the pitch, compared to the solid plate which would be 1. This is found by using tables of efficiency of seam (see Supplement) directly:

$$E = \frac{p - d}{p} = 0.863.$$

Now we will proceed to find the two factors of safety; one for tearing the plate and the other for shearing the rivets.

Factor of safety (tearing) $= F_t$

Using the formula, $$F_t = \frac{E \times (f_t \times t)^*}{P \times R} = \frac{.863 \times 34{,}375}{200 \times 29} = 5.11$$

Factor of safety (shearing rivets) $= F_s$

Using the formula, $$F_s = \frac{n \times A \times f_s}{P \times R \times p} = \frac{303{,}231}{200 \times 29 \times 7\frac{3}{4}} = 6.74$$

* From table of Boiler Calculation (see supplement) we get $(f_t \times t) = 34{,}375$ using 55,000 for new steel plate and the given thickness of plate "t" = ⅝.

From table showing shearing resistance of rivets (see Supplement), we get the total product, $n \times A \times F_s = 303{,}231$.

It will be seen from the above that the seam is strongest in the strength of rivets, as the factor is 6.74 compared to 5.11, which is the factor of safety on the tearing of the plate. Now as 5 is an ample factor of safety in ordinary boilers in new work, we can rest assured as to the safety of this boiler.

When the water to be used is liable to corrode the boiler it is customary to take off 1/16 inch from t and allow for this. Plotting from these tables will give curves which are very valuable on account of enabling the designer to obtain results intermediate between those on tables.

Referring to the table on rivets (see Supplement) it will be noted that 38,000 was used as shearing strength of rivets. This is a fair average for good wrought iron rivets. A thumb rule of making the rivets twice the size of plate, in our example would give us 1¼-inch rivets, but it will be seen that 1-inch rivets are ample, and are enough to give a large factor of safety. The rivet holes are generally made 1/16 inch larger than the rivet to be used, and as the rivet fills the hole after being driven, the size of the hole is used in the calculation table. An efficiency of seam of 0.85 or over is desirable if possible, but this alone does not determine the strength of a boiler, and this quantity is often allowed smaller, according to style of seam used.

[The procedure here outlined is a good one for determining the dimensions of a proposed joint, but the joint thus determined should still be tested for strength by other methods of failure than the two just given. Shearing at the outer row of rivets and tearing at the middle row may, for instance, give a lower factor of safety than tearing at the outer row.—Editor.]

* * *

A system of standards is the order of modern life, and in many directions standards are convenient if not, in some cases, indispensable. We have, for instance, standard gages for railways and tramways, standard threads for various screws, and so on. But there are still some directions in which the need of a standard is not only indicated but is urgent. The desirability, for example, of standardizing the steps of all staircases is seen in the fact that so often a fall on the staircase is due to the irregularity in the height of the steps. A common cause of accident on the staircase is the kicking of the edge of a stair when ascending. In descending, also, an irregularity in one step may easily upset the equilibrium of a person. Yet how many staircases are constructed absolutely alike as regards the height of the steps? We should say very few; and not only is there little uniformity existing between different staircases but the steps themselves in the same staircase are often irregular. Staircases and the steps in them should be standardized; there should be uniformity of height and breadth, and in regard to the latter there should be room enough on the step to accommodate the whole foot from toe to heel, so that there is no undue call on the energies when ascending, as by going on tiptoe, so to speak, or any feeling of insecurity when descending by reason of there only being room for the heel. Even in dark places the staircase, if standardized, would be more safely negotiated than a well-illuminated but irregular stairway. The perils of an ordinary ladder would be enormously increased if the rungs were placed at irregular intervals.—*Lancet.*

* * *

A remarkable improvement in incandescent electric lamps is reported to have been made by Prof. H. C. Parker and Mr. Walter G. Clark of Columbia University, New York. The new lamp is claimed to have from three to four times the efficiency of the ordinary incandescent lamp using a simple carbon filament. The filament is a compound structure with a carbon filament as its base on which are deposited other materials including silicon; it is called "helion," because its spectrum is similar to that of the sun. It is also claimed that the new filament of the new lamp will last nearly twice as long as the carbon filament, giving as high as 1,270 hours service and an average of about 1,000 hours service before failure. An efficiency of 1 watt per candlepower hour has been reached with the helion filament lamp. The ordinary 16 candlepower incandescent lamp requires from 50 to 54 watts as against say 16 watts for the new lamp.

FINISHING CUTS WITH HIGH-SPEED STEEL.

ROBERT GRIMSHAW.

At a meeting of the Hanover section of the German Engineers' Society, I made the remark, in speaking upon a very interesting paper by Prof. Hermann Fischer, that my experience with the new high-speed steels went to show that, while they would rough out about three to five times as fast as the carbon steels, they were not to be recommended either for finishing cuts on the lathe, or for milling cutters; and that my own rather expensive experience was backed up by the results obtained by others in Germany. This remark was simply laughed at by the author of the paper in question; and the chief engineer of the Egestorff Works agreed with the learned professor that the new steels did first-class work in lathe finishing and in milling. In order to fortify myself in the premises I wrote to a number of leading German machine builders, noted for turning out good work and plenty of it, and asked for their experience in the matter. Their testimony coincides without exception with my own, and I take pleasure in giving abstracts therefrom as an interesting contribution to the literature of the subject.

It should hardly be necessary to say that the reason why we should not expect proportionately as good work in finishing as in roughing is that the new steels, almost without exception, require to be almost, if not quite, red hot, in order that their molecules may arrange themselves in mechanical grouping or in chemical combination so as to give the maximum hardness, and that in consequence of the high speed required to get this temperature, and their tearing rather than cutting action, the surfaces obtained are not so smooth as those got with the carbon steels.

The experiments of Prof. Haussner, of Brunn, go to show that a slight increase in specific power required to produce turnings accompanies an increase in the speed of cutting; and this is at once the cause of the new tools getting hot when roughing, and the reason why they cut so fast. But in finishing on the lathe or planer, there is less heat developed than in roughing. In milling, there is, in the first place, no machine that will give the speed required to make the tool red hot; and in the second place the weight and cross-section of the body of the mill, in proportion to the cutting portion proper, is so great that in any case only slight heat developed by the work is rapidly carried away from the point of application of the cutter. Further, the teeth are not constantly at work, as is the case with the point of a lathe tool; and each tooth has a chance to cool off "between bites." This being the case, we have not the combination of circumstances tending to produce that high temperature of the cutting point, or points, necessary in the case of the new steels to do fast work. In a paper before the American Society for Testing Materials, Mr. Metcalf said in effect (I quote from memory): "As far as we know, the users of high-speed steel have not been able to make tools that will finish satisfactorily; therefore, they use for this purpose carbon-steel tools, after they have done the heavier, rougher work with the high-speed steels."

But to get down to the promised testimony of German tool manufacturers and machine builders:

The Zahnräderfabrik, formerly Joh. Renk, Augsburg, writes: "We have had the best of results with the new steels in milling, planing, and turning; for finishing on the lathe high-speed steel is not at all necessary. These are our results:

CUTTING FEEDS AND SPEEDS FOR HIGH SPEED STEEL.

MATERIAL.	CUTTING SPEED PER MIN.		FEED.		DEPTH OF CUT.	
	Meters	Feet *	Millimeters.	Inches.	Millimeters.	Inches.
Cast Iron (without skin).....	9	29.52	2	.079	6	.236
Cast Iron (with skin).........	8	26.24	2	.079	5	.197
S.M. Steel (without skin).....	11	36.08	1.5	.058	6	.236
Steel Casting (with skin)...	9	29.52	1 to 1.5	.0394 to .058	5	.197

* All equivalents in British units added by the author.

"The above cutting speeds are about twice as great as with the ordinary steel. Our machines do not permit of taking heavier cuts, and for the same reason we could not attain higher speeds."

De Fries & Co., Düsseldorf, say: "The rapid steels are used by us only for roughing, while fitted surfaces are ground." They also say, in reference to the speeds attained in roughing when the machine is suitable for the work, that these depend upon the hardness and toughness of the material being cut, upon the feed, etc., and vary from 6 to 30 meters (19.68 to 98.4 feet) per minute.

The Vereinigte Schmirgel- und Maschinen-Fabriken, Hainholz near Hanover, write in very great detail:

"We introduced the self-hardening steels in our works about a year and a half ago, for lathes and planers. In order to get the best results we tried eight different makes. The principal materials worked are cast iron and ingot iron. In the case of gray iron the crust made a great difference. The high-speed steel does not stand up to its work on the skin any better than the ordinary steel. In order to get good results, the skin must be taken off at the same time with the rest. As in a paying works it does not do to remove much material, say, for small pieces 2 to 3 millimeters (0.08 to 0.118 inch), for larger work 4 to 6 millimeters (0.16 to 0.236 inch) it must be understood that at times the tool must work on the crust, too. For average gray iron with a depth of cut of about 5 millimeters (0.197 inch) our maximum cutting speed is from 13 to 15 meters (42.6 feet to 49.2 feet); with harder cast iron, 10 to 12 meters (32.8 to 39.4 feet).

"The maximum work attainable can be got in one of two ways: either by low cutting speed and heavy feed, or by high cutting speed and less feed. The first seems the better way. As far as the working of Bessemer steel and castings is concerned, the limits lie higher. For us, the figures are as follows:

"Ingot iron, unforged, 20 to 24 meters (65.6 to 78.72 feet); ingot iron, forged, 18 to 20 meters (59 to 65.6 feet); ingot steel, 20 to 30 meters (65.6 to 98.4 feet); crucible steel, 5 to 7 meters (16.4 to 22.96 feet), according to depth of cut and feed.

"By reason of the heavy work that the high-speed steel has to do, the heat of friction comes unpleasantly into the foreground; this being manifested by heavy pressure on the lathe centers. There are also limits set to the cutting speed on long thin shafts, by reason of the bending of the work-piece. When remarkably high cutting speeds are given in circulars and examples of work done, it is to be understood that these refer to roughing cuts, such as are usual in steel works. In machine building, however, accuracy is demanded; that is, as exact a surface as possible. If we finish at high speeds, chattering occurs, despite all precautions. And in practice, that means a rough surface.

"Outside of this, however, the self-hardening steel is at a disadvantage in contrast with the ordinary. As has been shown often, as for instance in '*Stahl und Eisen*,' No. 10, of 1904, the chips or turnings are not removed by the cutting edge proper, but torn off under heavy pressure. This necessarily yields a rough surface. If, however, we finish at the ordinary speeds, such as are right for the ordinary steel, say 5 to 7 meters (16.4 to 22.96 feet), the surface will be smooth. The self-hardening steel can here hardly claim precedence over the ordinary. It is noteworthy that H. Wohlenberg of Hanover says in his circular of lathes with triple backgears: 'For roughing cuts at high speeds with fast-cutting steels and for finishing cuts with ordinary steel.' In our workshops the fast-cutting steels are used almost exclusively for roughing, and at the speeds suited to each material; above all for the skin of castings.

"For all that, the introduction of high-speed steel is of enormous importance. There are materials that cannot be worked at all with ordinary steel. Now we use these new steels at moderate speeds. This is true of boring and planing. A great evil is the high price, 5 to 7 marks per kilogram (55 to 77 cents per pound avoirdupois). But this can be partly eliminated by the use of toolholders, much to the displeasure of the steel dealers. With us, the welded tools are much liked, especially by the planer hands.

"As regards the grinding of the high-speed steel, the circu-

lars always say 'grind only wet.' That is not right. As you know, in grinding, hair-cracks easily occur, which under certain circumstances can lead to trouble. We grind only on emery wheels. If in wet grinding the tool is pressed a little too hard against the disk, the cooling-water does not reach the place of contact, but flows over the edge of the tool, so that the latter is cooled in front and heated strongly on the back, which gives rise to hair-cracks. If, however, the grinding is done on a dry wheel, the steel will be heated uniformly; this will not injure it, provided the temperature does not get too high. It is therefore better to grind these tools carefully on a dry wheel. In general, we can say that the self-hardening steels have made themselves much liked by the workmen, although at first they fought against them tooth and nail."

Körting Bros. of Körtingsdorf near Hanover, a firm of world-wide reputation, say: "We have gone back from a formerly quite liberal purchase of high-speed steel, because we found that most of our lathes were too weak for them. For our large lathes, on which crank-shafts and connecting-rods are turned, we get the material from the steel works already roughed, and when in finishing we let the lathe run at the speeds called for by the fast-cutting steels, in most cases the proportionately long shaft chatters so that a smooth and round surface is not to be obtained. Also, connecting-rods get warm very easily, and twist. For this reason we use in our shops the high-speed steel for finishing only because we have it on hand. In our opinion fast-cutting steel can only be used to advantage for roughing, and on sufficiently strong lathes.

"We are about to try high-speed steel for milling cutters; our experiments are, however, not yet ended. For drills this steel is only practical where there are heavy fast-running machines.

"In general, we believe that at first there was more high-speed steel used than was economical. This is confirmed by the agents of the steel works, who have told us that there is already an over-production, and that the sale of fast-cutting steel is not so heavy as the steel works at first expected."

Fr. Stolzenberg & Co., manufacturers of fine gears, Berlin, say:

"We have the experience in our works, that the different high-speed steels for lathe work and milling are but little suited for finishing, and especially for work with light cuts, because the surfaces obtained thereby look less neat than those obtained with tools of the ordinary quality of steel. For roughing out, where the appearance of the surfaces worked makes no difference, these steels offer, naturally, great advantages."

It is to be remembered that Mr. Mould told the American Master Mechanics' Association (I quote again from memory) that although high-speed steel costing 65 cents a pound often replaced to advantage low-grade carbon steel at 10 cents, the saving in comparison with ordinary steel at 16 cents was not so great.

In the use of milling cutters and reamers with heavy central portions there is no trouble as regards conducting away the heat, because the central portions are usually of large enough cross-section to carry away all the heat. Here, however, there is a very great inconvenience—too little room for the chips. This is at any rate the case where the usual number of cutting edges is employed. This is, of course, remediable by having fewer cutting edges and more space between them. When the time saved in using the new steels is very short, as is the case where they do not work at the high, that is, the roughing, speeds, the saving by their use is confined to that owing to their greater durability. When the time necessary to do the actual cutting is short in comparison to that required to chuck the pieces, the saving by the use of the new steels is again reduced to little more than that due to their greater durability.

Gledhill says in the *Iron Trade Review* that in many cases the new steels are not so good for finishing cuts as special water-hardening carbon steels. G. M. Campbell, in the *American Machinist*, says that the new steels are not good for light cuts, or for finishing. Becker and Brown say in the *Engineeering Magazine* that a tool of the new steel cuts quite differently from one of carbon steel; it wedges off the material, hence gives rougher surfaces than one of carbon steel. It is certainly the case that the new steels have not shown themselves so good on gray iron as on steel, and that on brass they have not given satisfaction.

The reason why the new steels work better on steel than on cast iron is explained by Corby by the fact that in turning steel with any steel tool, at high cutting speeds, there is formed on the upper side of the tool a hollow, caused by the friction of the turnings. There is also formed on the cutting edge a slight elevation of turned-off metal, welded on the tool by the heat of the work. The deeper the cut, the further the hollow is from the edge. In cutting cast iron this does not take place. So with steel the tool wedges off the material, instead of cutting it, and the point of separation of the turning from the work-piece lies ahead of the cutting edge, instead of directly before it. The heavier the turning, the more the resistance, and the further back it rolls on the tool. The tool splits off material as a wedge splits wood lengthwise, always in advance of the edge.

I think I have given enough instances to prove the correctness of my assertion, that while the new steels are very well adapted to roughing, they are not suited to finishing-cuts on the lathe, nor for milling, which, naturally, is supposed to be an operation delivering finished surfaces.

* * *

The New York and Long Island Railway Company, known as the Belmont or old Steinway Tunnel System, have just awarded a contract to the Otis Elevator Company for the two largest escalators ever built to be installed in the Manhattan terminal of that system at 42d Street, between Lexington and Third Avenues. Trolley cars instead of trains are to be operated in this tunnel and these running on short headway provide a tremendous capacity. It is estimated that the capacity will be at least equal to that of the trains of the present Brooklyn Bridge during rush hours and the escalator equipment above referred to is equal in point of capacity to that of the entire stairway equipment of the Manhattan end of the Brooklyn Bridge. Furthermore, not only will the escalators be sufficient to handle any number of people up to the capacity of the trolley cars of the tunnel but they will also serve to marshall the crowds into streams of people moving uninterruptedly and not coming into conflict with one another. The escalators will provide service between levels something over 55 feet apart and will be arranged side by side. Most of the time one will be operated ascending and the other descending but during the morning rush hour both will be operated ascending.

* * *

The invention of the tapered die for cutting pipe threads, according to the *Valve World*, is that of Mr. T. W. Gates of Chicago. Mr. Gates was a blacksmith and in his work years ago found it very difficult to start a straight-thread die on a bolt, whereupon he hit upon the idea of making the die with a tapered thread, which proved to be a success. The same idea was applied to threading pipe, and in this case gave the additional advantage of a tapered thread, which made for additional safety in getting a tight joint. It is alleged that Mr. Gates collected a royalty on the idea for a number of years, which, perhaps, confirms his claim as an inventor of this idea. However, this idea in common with so many others would seem to be one that would naturally follow the use of solid hand dies that it is difficult to believe that there is any "first" man who can definitely prove his claim to its origin.

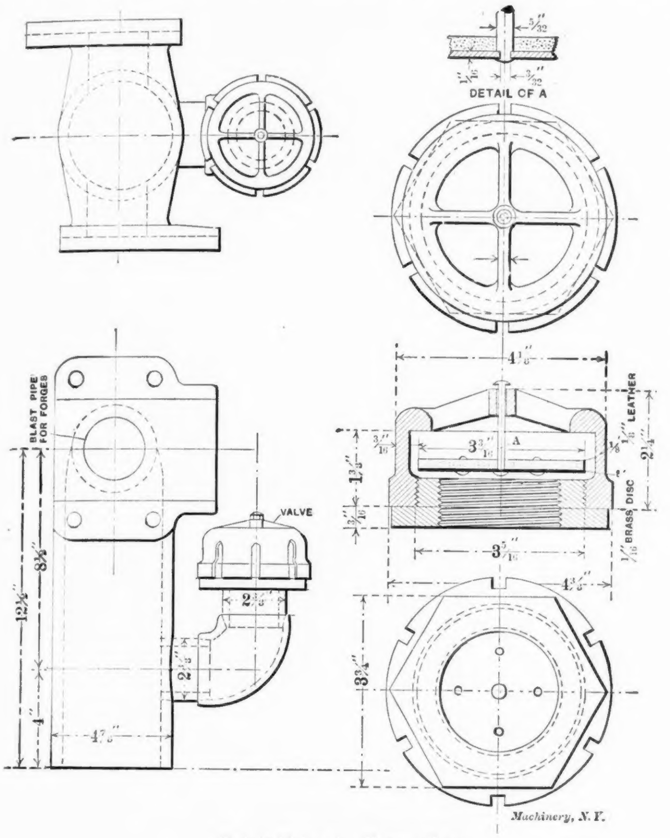
* * *

A thoroughly organized selling department is a vitally important part of every successful manufacturing industry, but it is one of those obvious facts that a "practical" mechanic is very prone to underestimate or ignore when he contemplates starting into manufacturing on his "own hook." To illustrate what selling machinery, even of the heaviest type, costs it may be mentioned that one well-known concern, which is reputed to have the best organized and most efficient selling department in the United States, has found that its selling cost is 18½ per cent of the manufacturing cost.

LETTERS UPON PRACTICAL SUBJECTS.

SAFETY VALVE FOR BLAST PIPES.

In view of the fact that there are and have been so many large modern smith shops erected in recent years, and there have been several cases to my knowledge where said shops have been put entirely out of business by terrific explosions of accumulated gas in the blast pipe, and as "an ounce of prevention, etc.," I submit herewith a design of a safety valve, which is self-explanatory. My sketch shows the valve applied to the upright pipe casting which is commonly used in double forges, although the same may be applied to any form of blast pipe.



Safety Valve for Forge Shop.

It has been found that fires which are left to smoulder during the night emit a great quantity of gas, and the blast fan not running, the piping system forms a natural draft for the gases, which accumulate in the pipes and, no doubt, are ignited by some of the fires in the forges which continue to burn more or less; hence the explosion.

It will be noticed that this valve, if placed as shown, will allow the gases to escape, as the leather-seated disk valve will drop or unseat as soon as the blast fan stops or the pressure is off the under side of valve. My attention has been called to the fact that just recently two explosions of this kind occurred. In one case a large blast fan and its entire pipe connections were completely ruined by a terrific explosion of this kind and the whole shop put out of business for several days. To a practical man the necessity of an immediate installation of something of this kind, if the question has not already been considered, is most apparent. ALBERT P. SHARP.

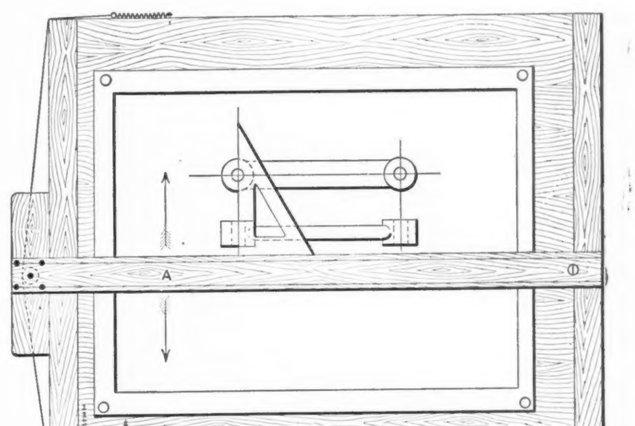
Williamsport, Pa.

ARRANGEMENT FOR HOLDING T-SQUARE IN PLACE.

The accompanying cut shows a very simple, cheap and effective arrangement for holding the T-square against the edge of the drawing board. The materials needed are a small wooden grooved wheel, a sufficient length of heavy cord about 3/32 inch in diameter, a coiled spring to give sufficient tension to the cord, and a few screws, all arranged as shown in the cut. A strong rubber band can be used in place of the spring but of course is short-lived. The wheel is fastened in the center of the under side of the T-square head. On small boards it may be advisable to fasten a small triangular block at the lower left hand corner of the board so as to allow the T-square to be used when the drawing is near the edge of the board.

To one accustomed to the old method of moving the T-square by grasping the head and continually lining it up, the advantage of this simple device will be a surprise, as the T-square can be moved easily by applying the hand at *A*, about eight inches from the head, and when moved out of line it automatically returns to its proper place. I often have persons come to my board to inspect a drawing. Naturally they try to push the T-square out of the way. Imagine the surprise when the T-square swings around quickly into place again like a live thing.

An important advantage is, that in keeping the head snug against the edge of the board, the wear on the ends of the head where it slides on the board is avoided. This wear is caused on the ordinary T-square by the uneven pressure when sliding it up and down. The edge gradually becomes slightly curved, resulting in non-parallel lines on the drawing. Most draftsmen are not aware of this defect. The T-square is quickly detached by simply lifting it off the board, the cord slipping easily from the wheel. To find the proper tension for the cord, the T-square should be put in the center of the board, the cord fastened to the lower edge of board and brought around the wheel to a loop in the end of the spring which is fastened at the upper edge of the board. Now swing the T-square around so that it lies on an angle of about 30 degrees to the center, keeping one end of the head against the edge and near the center of the board. Increase the tension on cord until it is sufficient to cause the blade to swing quickly into place. In other words it should be so tensioned



Arrangement for Holding T-square in Place.

that no matter in what position the T-square is left, it will immediately return to proper position. This scheme can be applied to any common T-square up to 42 inches long. The writer has used a 42-inch T-square for some time. Of course it is preferable to use as light a T-square as possible. Note that the cord is not wound around the wheel, but simply bears on it exactly as a trolley wire on the trolley wheel.

S. J. B.

ON THE OBJECT OF TECHNICAL TRAINING.

When I see anything like the extract from the paper of Mr. Thomas Hill which you presented on page 81 of the October issue (Engineering Edition) it sets me first to boiling over and then to thinking. I have no wish to champion

technical schools nor any particular technical school for anything other than what it is and what it does. My connection with the school of which he apparently writes was of such short duration as to give me absolutely no right to speak for it with authority, but I cannot see you present even another person's views written in so unjust a fashion without a protest. For Mr. Hill to say that any technical graduate "is given a diploma, signifying he has nothing more to learn," etc., is a rank outrage. It ought to deceive no one but it will if allowed to pass unnoticed, without a doubt be the turning point in some young man's career. And if even one young man, discouraged by your repetition of Mr. Hill's statement, may be persuaded to stop and reconsider then my efforts will be well paid.

Suppose that every statement alleged by Mr. Hill were true. What then? It shows that some young man had spent three or four days doing a job whose commercial value was nil. But during the intervening time this young man had doubtless also covered numerous sheets of paper with worthless figures and had burnt untold cubic feet of gas of a distinct commercial value to learn various things having a rather distant relation to drafting. And what had the young man learned while he was spending these three or four days making this worthless bit of material? He learned to hold a hammer and a chisel, to hold a file, to use patience. He learned to know how little difference there is between a good fit and a loose one or no fit at all. He had that invaluable experience for any man. *He had been compelled to stick to a job till he did it well.* How many men have spent three or four years instead of three or four days learning that simple thing? For my own part I freely admit that I consider it much better to take a green hand and start him right into the middle of things, but you cannot persuade many men, either in or out of the shop, that this can be done. It is astonishing even to those who are in daily touch with students how fast they develop and how quickly they grasp things that in the ordinary shop they would not be allowed to touch till they had worked a great deal longer time than the "tech boys'" whole shop course. Time and cost are essentials but not all the essentials of production as I know to my sorrow. My father had an idea like Mr. Hill's. He believed that time was the one essential. He taught me to do what was set before me promptly, and do it quick. No matter how it was done if it was only done in a hurry. He thought that thoroughness would come later. But it never did. And it cannot be expected to. Of all things, boys, learn to do what you do well. You can learn to do things quickly and well only when you can do them as a matter of habit. You cannot afford to pay tuition to any school while you are learning to do things quickly as well as thoroughly because there are plenty of shops that will gladly pay you living wages to do it their way, and this in spite of the fact that the superintendents of these very shops may unthinkingly condemn the way you were trained. If they say anything to you just ask them what they are doing to get their own apprentices over the road and they will take to the woods in a hurry. If you want to go to some technical school where less stress is put on hand work and more on machine work, there are a plenty of them. See the articles which Mr. Fairfield of the Worcester Polytechnic had on machining simple machine parts if you want an idea of what is done there. There are others, too. But if you do go to one of these other schools do remember that your shop work as well as your other school work is only a foundation on which to build. That is all that any school can do for you. And when you build on this foundation and the shrubbery and the moss grow up around it and hide it from view, don't forget that that is what is holding you up. "ENTROPY."

DOES STEEL CRYSTALLIZE?

In a short note which appeared in the Engineering Review section of the December issue of MACHINERY, Mr. James H. Baker claims that there is no such thing as the crystallization of steel by shock or vibration. He claims that where cases occur in which crystallization is suspected they simply reduce themselves to defects that have existed in the steel from the beginning. I cannot agree with him for in my experience there is no room for doubt as to the numerous cases of crystallization. For example, I have replaced steel shafting which would repeatedly break at the same place each time, and the breaks would show crystallization or separation of the faces of the crystals. I do not think that the test given by Mr. Baker—that of hammering and bending by a press—is fair, inasmuch as crystallization is brought about by thousands of shocks or bends which in many cases may extend for a period of several years. L. A. WHEAT.

Battle Creek, Mich.

PORTABLE DRILL SUPPORT.

In building machines which are not made in large enough quantities to warrant the expense of a full equipment of drilling jigs, it quite frequently is necessary that a number of

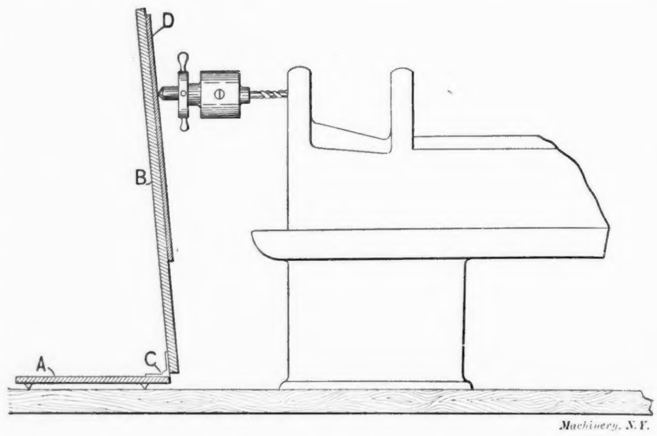


Fig. 1. Portable Drill Support in Use.

holes be drilled while assembling various brackets. It is then found inconvenient to use a power radial drilling machine and usually the air or electric portable hand drill is utilized. Under ordinary methods, when the diameter of hole to be drilled is over 5/16 of an inch in diameter, it is considered a rather hard and unpleasant job to both support and feed the drill into the work. The accompanying cuts, Figs. 1 and 2, give a general idea of a supporting device for

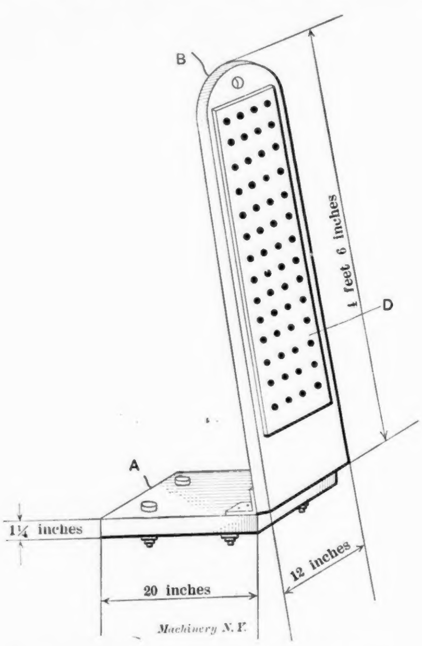


Fig. 2. Detail of Support for Portable Drills.

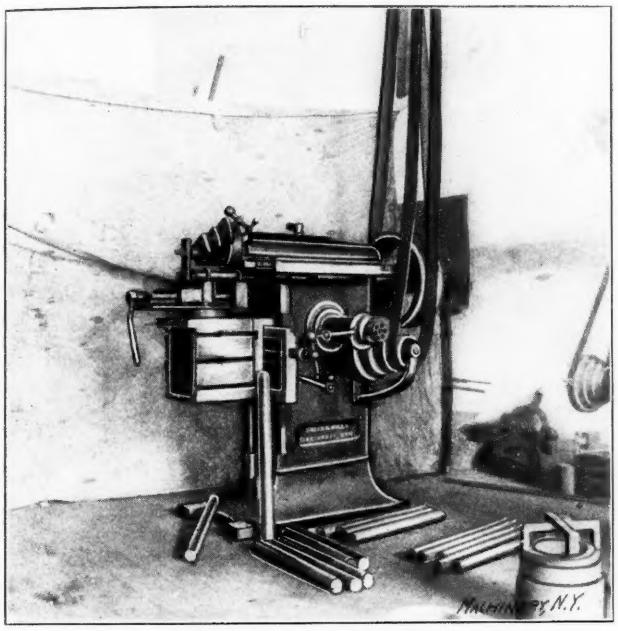
hand drilling which is used quite extensively in one of the large eastern tool building shops and has been found a very satisfactory arrangement.

The support is "made up" of two main parts—a base, *A*, and a swinging upright, *B*. These two members are joined by heavy hinges, *C*. The base has four projecting lugs on its under-side which are sharp enough to slightly sink into the

floor when the workman stands on the base. When in use the outer end of drilling apparatus is located in one of the many center holes in the steel plate D, the center hole selected being one approximately in line with the hole to be drilled. The workman forces the drill into the work by bringing the weight of his body against the swinging upright B. This may seem rather crude but in actual use the lack of "gracefulness" is more than balanced by the ease of manipulation. In drilling holes over 1⅛ inch in diameter, the screw feed is used for feeding, and in this case a sling is thrown over the top of upright B and the work, this simply preventing any backward movements of the upright. C. L. G.

MILLING ATTACHMENT FOR THE SHAPER.

The accompanying halftone shows a milling attachment, adapted for the shaper, and intended for milling keyseats in shafts 2 inches diameter by 24 inches long. The keyway is milled to a depth of 3/16 inch by ⅜ inch wide the full length of the shaft. The time required for milling each shaft is about 45 minutes. Some of the finished pieces will be seen on the floor beneath the shaper. As the shaper is a very old style one, there was barely 1⅛ inch between the rocker head



Milling Attachment for the Shaper.

and the inside wall of the shaper, which made the design of the attachment more difficult. The end thrust is taken up by removing the toolpost and screwing in a shoulder stud to which a clamp is fitted with a set screw provided with a lock nut, the attachment being similar to that of a regular milling machine. This arrangement is shown in the cut. The cutter is driven directly from the countershaft by a wooden pulley on the rear end of the spindle.

San Antonio, Texas. LEO DE HYMEL.

TO FIND THE RADIUS OF AN ARC WHEN THE LENGTH OF THE CHORD AND THE HEIGHT OF THE ARC ARE GIVEN.

In the November issue Mr. Falk gives a description of how "to find the radius of an arc when the length of the chord and the height of the arc are given." I send you herewith a formula for the same, which, perhaps, is somewhat plainer.

$A =$ the height of chord,
$B =$ half the length of chord,
$R =$ radius of arc.

Then $R = \dfrac{A^2 + B^2}{2A}$.

Stockholm, Sweden. J. LUNDIN.

[One or two other correspondents have called attention to what they consider the ungainly form in which this formula appears in Mr. Falk's contribution. There is something, however, to be said in his defense, and the matter is of enough importance to warrant a few words.

The most compact and concise arrangement of which a formula is capable is not necessarily the easiest one to use in practice. Let us take the example, for instance, of an arc whose chord is 1.47 long and whose height is 0.38. Let it be required to find the radius of the arc. Mr. Falk's formula is:

$$R = \frac{\dfrac{\left(\dfrac{L}{2}\right)^2}{H} + H}{2} \qquad (1)$$

Mr. Lundin's formula changed to correspond to the problem as stated by Mr. Falk is:

$$R = \frac{\left(\dfrac{L}{2}\right)^2 + H^2}{2H} \qquad (2)$$

It will be noted that the length, not half the length, of the chord, is given, thus necessitating the change. For values of L and H just taken we have solved both equations 1 and 2 in the example below, using as few figures as possible and carrying the answer out to the third decimal place in each case.

```
        Equation 1.                       Equation 2.
   1.47                              1.47
    .735                              .735
    .735                              .735
  -------                           -------
    3675                              3675
   2205                              2205
  5145                              5145
  -------                           -------
  .540225  (  .38                   .540225
   38        -----                      .38
  -----      1.422                      .38
   160        38                       -----
   152       -----                      304
  -----      1.802                     114
    82                                 -----
    76       .901 = R.           .38   .1444
  -----                            2   .540225
    62                           -----  -------
                                 .76)  .684625  (.901 = R
                                        684
                                       -----
                                         62
```

It will be noticed that Mr. Falk's more complex formula requires 56 figures while the simpler formula requires 66, and there is a corresponding saving of time with the first way of doing it. The reason is clearly seen. The original form of the equation gives a consecutive calculation. The second form requires first, the squaring of $\dfrac{L}{2}$, then the squaring of H, and and then the addition to it of the previous result before we can complete the problem. The first method will be found much the easier of the two to use in practice. We are willing to admit, however, that it might better have been given for the diameter, and taken the form:

$$D = \frac{\left(\dfrac{L}{2}\right)^2}{H} + H$$

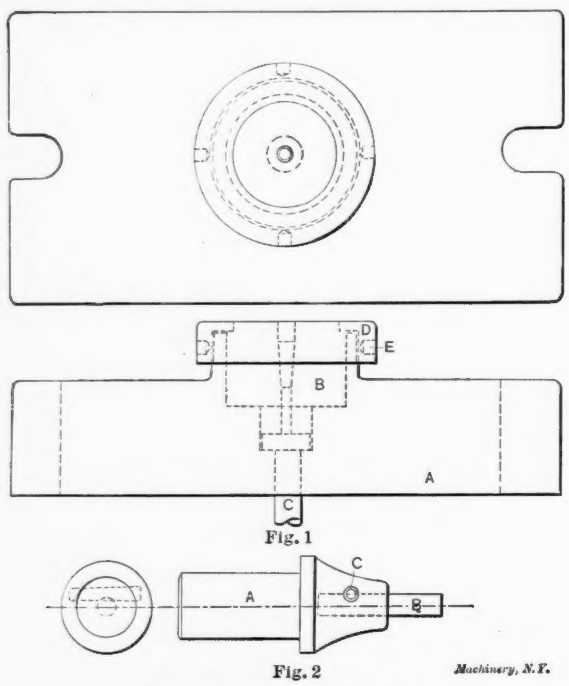
If it were a question of remembering the formulas, there would be no comparison. Mr. Lundin's arrangement is superior. But it is foolish to try to remember too many formulas; they should be kept where they are easily available and may be referred to when necessary. In deriving a formula and arranging it for practical use, it is much better to put it in a form that will allow a consecutive calculation from beginning to end, where possible, than it is to try to give it the simplest *looking* arrangement as it appears on the printed page.—EDITOR.]

MAKING TAPER PINS BY PUNCHING.

Recently I had occasion to decide how to make, and to design the tools for making several thousand pounds of special taper pins from cold-rolled steel to be used as parts of special machines. The first thought was to turn them in an automatic screw machine with tools of customary design for such work. But instead of the screw machine we decided to try the punch press; after some experimenting, pins of satisfac-

tory dimensions, and sufficiently smooth to be acceptable for the purpose, were turned out. The cost of production in the press was about fifty per cent below what we figured it would be in the screw machine, and less stock was used than if we had adopted the latter way of doing this work. No loss by turning off the stock is required when making the pins in this way. After the length of the blanks was determined by experiment we cut them up in a cutting-off machine and then literally punched them to size.

The cuts show an elevation and plan of the punch and die. Fig. 1 is the die, consisting of the steel holder *A*, cast extra thick to withstand any tendency to flexture, and the die proper, *B*, made of tool steel and as hard as fire and water will allow, and not drawn. After hardening, the taper hole was lapped very smooth to minimize friction and permit of easier stripping of the pins. Two sections of the hole in *B* are made straight; the upper part receives the work and holds it in a



Making Taper Pins by Punching.

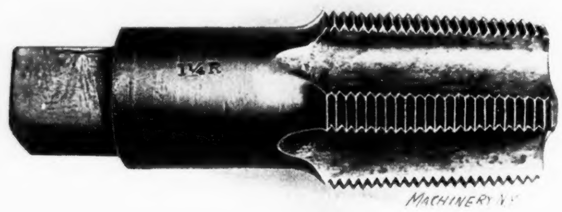
vertical position so that the end may come directly in contact with the end of the punch on the down stroke. The lower section is also straight, and to it is fitted the upper end of ejector *C*, which is caused to slide up and down by a lifting device connected to the ram of the press. This lifts the work on the up stroke of the press ram to a sufficient height to be conveniently removed by the operator. The die is seated in the holder and retained there by the cap *D*, which is screwed tightly to holder *A*. Four holes, *E*, equidistant are for inserting a piece of drill rod to tighten the cap. The parts that constitute the punch, Fig. 2, are holder *A*, the punch *B* made from drill rod and hardened, and the taper pin *C* holding the punch in place.

In conclusion it may be pointed out—though it is perhaps so obvious as scarcely to need it—that taper pins may be made in the punch press longer than the one shown in the illustration and of more taper, the limit of the latter condition being governed by the ductility of the metal and the pressure applied. ENGINEER.

THREADING WROUGHT IRON VS. CAST IRON.

The accompanying cut shows a 1¼-inch pipe tap which up to the time of photographing, had tapped 10,000 pieces of malleable iron parts and 10,000 pieces of cast iron. All the pieces were ¾ inch thick, thus making 15,000 lineal inches or 1,250 feet of metal tapped, and the tap is "just as good as new"; if it had worn any below size it could not be used as the parts tapped are used in automobile construction which means a vastly different requirement from the indifferent fits of common wrought iron nuts. This same tap would go on tapping wrought iron for years and perhaps would tap a million of wrought iron nuts. Comparing wrought iron to cast iron and malleable iron to brass, in regard to wearing out a tool, is in my opinion absurd.

The lower the heat we can harden a tool of any kind at, the better it is for the tool; for instance, I would harden a tap for tapping wrought iron nuts at a very low heat, thereby getting a fine grain, but this tap would not hold up to size very long if put to work on cast iron or malleable iron because it would not be hard enough. I always find out what is required of a tap or tool of any kind before I put it in



Tap with Good Record.

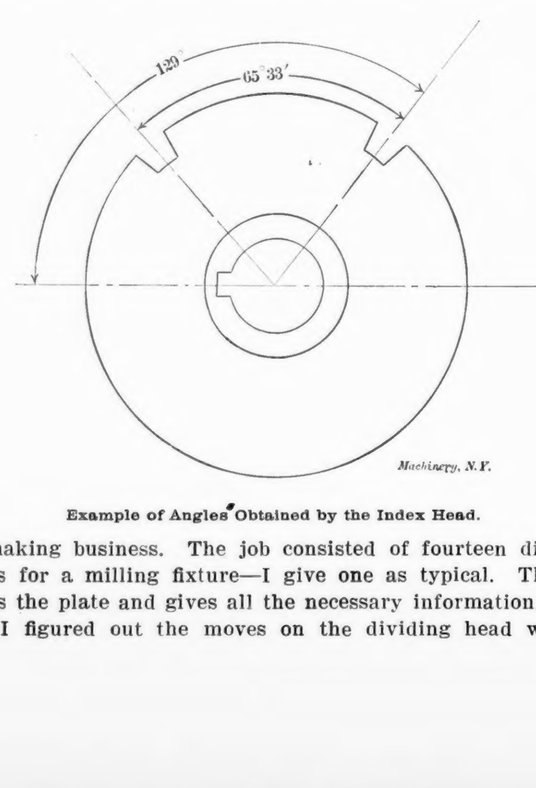
the fire and then temper accordingly. So a tap that I would temper for wrought iron nuts would be too soft to stand the wear for any great length of time if used on harder metals. About the only way I ever saw "boughten" taps give out is to break in pieces, because they are just as hard inside as they are on the cutting edge. What we want in a tap is toughness in the body of the tap and the teeth just hard enough to stand the wear of the metal it is to be used on. The tap shown here was heated in a charcoal fire covered completely, and at a very low heat, with blast shut off. It was dipped in cold salt water just long enough to harden the teeth, then the tap was put in fish-oil and let remain there until cold.

The teeth on a tap will harden at a very low heat, and the lower the heat the better for the tap. If interested in first-class tempering, experiment on an old broken tap and see at how low a heat it will harden. I am not at all surprised at the number of broken tools seen in some shops considering the heat they are dipped at; the grain in them looks like cast iron. They cannot be anything else than brittle, and bear in mind that drawing to a color will not restore the grain. J. F. SALLOWS.

Lansing, Mich.

OBTAINING DEFINITE ANGULAR MOVEMENTS BY THE INDEX HEAD.

The job herewith described and illustrated came my way some time ago, and as it seems to be of more or less usual occurrence, I hope that it will be of interest to others in the



Example of Angles Obtained by the Index Head.

toolmaking business. The job consisted of fourteen division plates for a milling fixture—I give one as typical. The cut shows the plate and gives all the necessary information. The way I figured out the moves on the dividing head was as

follows: The circumference of the circle being 360 degrees, and there being 40 teeth in the worm wheel of the head, it follows: $\frac{360}{40} = 9 =$ number of degrees for one revolution of the worm; therefore $\frac{129}{9} = 14\ 3/9 =$ number of revolutions of the worm for 129 degrees, or 14 6/18 revolutions is the correct move.

The move for the second notch is compounded: $\frac{65}{9} = 7\ 2/9$ = number of revolutions for 65 degrees, and this expressed in form of a working number = 7 6/27.

TABLE OF MOVES FOR OBTAINING ANGLES WITH THE BROWN & SHARPE INDEX HEAD.

Angles, Deg.	Move, Revs.	Angles, Deg.	Move, Revs.	Angles, Deg.	Move, Revs.	Angles, Deg.	Move, Revs.
1	2/18	1 1/3	4/27	1 1/2	3/18	1 2/3	5/27
2	4/18	2 1/3	7/27	2 1/2	5/18	2 2/3	8/27
3	6/18	3 1/3	10/27	3 1/2	7/18	3 2/3	11/27
4	8/18	4 1/3	13/27	4 1/2	9/18	4 2/3	14/27
5	10/18	5 1/3	16/27	5 1/2	11/18	5 2/3	17/27
6	12/18	6 1/3	19/27	6 1/2	13/18	6 2/3	20/27
7	14/18	7 1/3	22/27	7 1/2	15/18	7 2/3	23/27
8	16/18	8 1/3	25/27	8 1/2	17/18	8 2/3	26/27
9	1	9 1/3	1 1/27	9 1/2	1 1/18	9 2/3	1 2/27
10	1 2/18	10 1/3	1 4/27	10 1/2	1 3/18	10 2/3	1 5/27
11	1 4/18	11 1/3	1 7/27	11 1/2	1 5/18	11 2/3	1 8/27
12	1 6/18	12 1/3	1 10/27	12 1/2	1 7/18	12 2/3	1 11/27
13	1 8/18	13 1/3	1 13/27	13 1/2	1 9/18	13 2/3	1 14/27
14	1 10/18	14 1/3	1 16/27	14 1/2	1 11/18	14 2/3	1 17/27
15	1 12/18	15 1/3	1 19/27	15 1/2	1 13/18	15 2/3	1 20/27
16	1 14/18	16 1/3	1 22/27	16 1/2	1 15/18	16 2/3	1 23/27
17	1 16/18	17 1/3	1 25/27	17 1/2	1 17/18	17 2/3	1 26/27
18	2	18 1/3	2 1/27	18 1/2	2 1/18	18 2/3	2 2/27
19	2 2/18	19 1/3	2 4/27	19 1/2	2 3/18	19 2/3	2 5/27
20	2 4/18	20 1/3	2 7/27	20 1/2	2 5/18	20 2/3	2 8/27
21	2 6/18	21 1/3	2 10/27	21 1/2	2 7/18	21 2/3	2 11/27
22	2 8/18	22 1/3	2 13/27	22 1/2	2 9/18	22 2/3	2 14/27
23	2 10/18	23 1/3	2 16/27	23 1/2	2 11/18	23 2/3	2 17/27
24	2 12/18	24 1/3	2 19/27	24 1/2	2 13/18	24 2/3	2 20/27
25	2 14/18	25 1/3	2 22/27	25 1/2	2 15/18	25 2/3	2 23/27
26	2 16/18	26 1/3	2 25/27	26 1/2	2 17/18	26 2/3	2 26/27
27	3	27 1/3	3 1/27	27 1/2	3 1/18	27 2/3	3 2/27
28	3 2/18	28 1/3	3 4/27	28 1/2	3 3/18	28 2/3	3 5/27
29	3 4/18	29 1/3	3 7/27	29 1/2	3 5/18	29 2/3	3 8/27
30	3 6/18	30 1/3	3 10/27	30 1/2	3 7/18	30 2/3	3 11/27
31	3 8/18	31 1/3	3 13/27	31 1/2	3 9/18	31 2/3	3 14/24
32	3 10/18	32 1/3	3 16/27	32 1/2	3 11/18	32 2/3	3 17/27
33	3 12/18	33 1/3	3 19/27	33 1/2	3 13/18	33 2/3	3 20/27
34	3 14/18	34 1/3	3 22/27	34 1/2	3 15/18	34 2/3	3 23/27
35	3 16/18	35 1/3	3 25/27	35 1/2	3 17/18	35 2/3	3 26/27
36	4	36 1/3	4 1/27	36 1/2	4 1/18	36 2/3	4 2/27
37	4 2/18	37 1/3	4 4/27	37 1/2	4 3/18	37 2/3	4 5/27
38	4 4/18	38 1/3	4 7/27	38 1/2	4 5/18	38 2/3	4 8/27
39	4 6/18	39 1/3	4 10/27	39 1/2	4 7/18	39 2/3	4 11/27
40	4 8/18	40 1/3	4 13/27	40 1/2	4 9/18	40 2/3	4 14/27
41	4 10/18	41 1/3	4 16/27	41 1/2	4 11/18	41 2/3	4 17/27
42	4 12/18	42 1/3	4 19/27	42 1/2	4 13/18	42 2/3	4 20/27
43	4 14/18	43 1/3	4 22/27	43 1/2	4 15/18	43 2/3	4 23/27
44	4 16/18	44 1/3	4 25/27	44 1/2	4 17/18	44 2/3	4 26/27
45	5	...	...	...	...	...	...

ANGULAR VALUES OF ONE-HOLE MOVES ON BROWN & SHARPE INDEX PLATES.

15 hole circle	= 36. minutes.	29 hole circle	= 18.620 minutes.
16 " "	= 33.750 "	31 " "	= 17.419 "
17 " "	= 31.788 "	33 " "	= 16.363 "
18 " "	= 30 "	37 " "	= 14.594 "
19 " "	= 28.421 "	39 " "	= 13.846 "
20 " "	= 27 "	41 " "	= 13.170 "
21 " "	= 25.714 "	47 " "	= 11.489 "
23 " "	= 23.478 "	49 " "	= 11.020 "
27 " "	= 20 "		

In calculating the angular values of one-hole moves, I found that 1/33 revolution of the worm = 16.363 minutes, and this number multiplied by 2 = 32.726 minutes. This was considered "good enough" and accordingly the move 7 6/27 + 2/33 was taken. The error resulting was 0.274 minutes and this reduced to linear measurement on a diameter of 6 inches = 0.00023 inch, which was in this case a negligible quantity.

A table is appended giving the number of revolutions for different number of degrees. In the column for the "move," the whole number, where given, indicates the number of revolutions, the numerator the number of holes additional, and the denominator the number of holes in the index circle to be used. A table is also given stating the angular movement of index head for movements of one space in various index circles.

Auburn, N. Y. JOHN PRICE.

WIRE CUTTER, LATHE CHUCK AND PLANER JACK.

The accompanying cuts show three old but very useful tools. Fig. 1 is a wire cutter; the principal dimensions given are suitable for a machine to cut off 7-16-inch diameter mild steel.

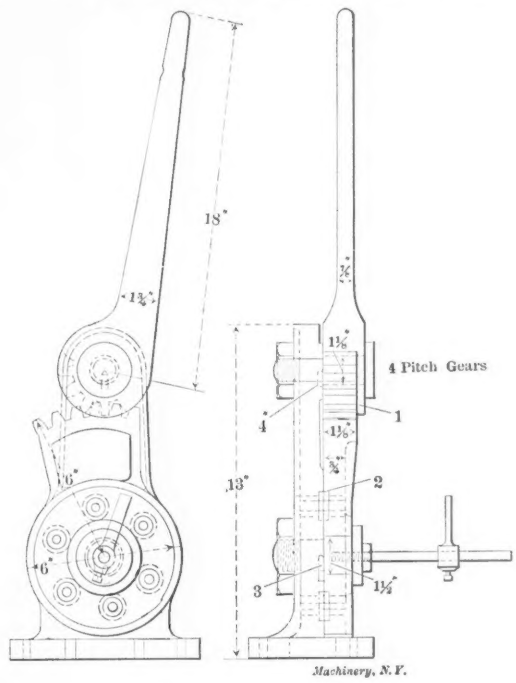


Fig. 1. Wire Cutter.

The pinion is shrouded as shown at (1); the cutters or bushings are, of course, made of tool steel and hardened. We have been in the habit of putting washers of tin behind the shoulder at (2) when the cutter became dull and then grinding flush, although no doubt this could be improved upon. At (3) and (4) are shown pin keys which key the studs from turning while assembling.

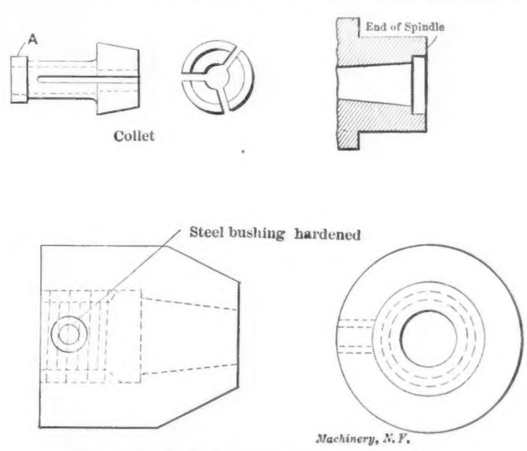


Fig. 2. Lathe Chuck for Screw Machine Collets.

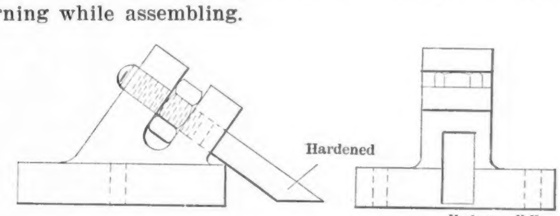


Fig. 3. Planer Jack.

Fig. 2 is a chuck to fit the engine lathe to permit the use of the spring collets for the screw machine. All that is necessary is the mild steel chuck and a spanner wrench, and to bore

a recess into the spindle of the lathe about 3-16 inch deep so that the part *A* of the collet will enter freely, but without play. I always use, wherever possible, a hardened steel bushing for the spanner hole.

Fig. 3 is a pinching down jack for the planer. It is much better than the ordinary loose piece and screw stud, especially when taking a finishing cut after relieving the strain, as there is no danger of the whole thing being thrown out or becoming loose by the terrible reversing shocks of some old planers.

J. T.

A WAY OF ARRANGING A COUNTERSHAFT FOR A LARGE PLANER.

The accompanying cuts show an ingenious way of arranging a countershaft for a large planer. The planer is placed in the middle of a large bay in which is a traveling crane.

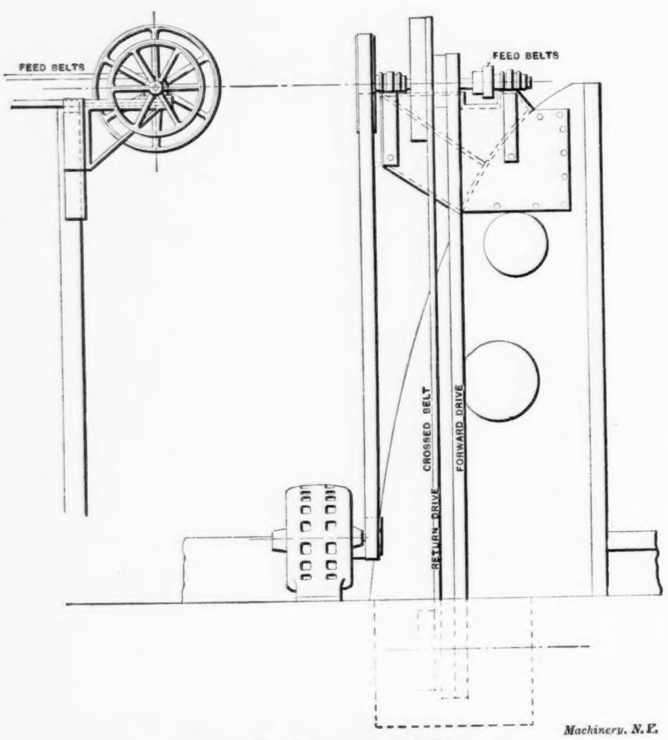


Fig. 1. The Countershaft in Place.

There are no timbers or trusses available on which to hang the countershaft. As there also is no room on the floor to set up the countershaft, it was finally decided to fasten a large bracket to the housing of the planer and attach brackets for the bearing boxes on this. Fig. 1 shows the way this was done and Fig. 2 shows the bracket in detail. Chipping strips are provided where the casting fits on the curved surface of the frame, and the cut shows the manner in which it was bolted on. The motor sets up close to the machine and the drive belt

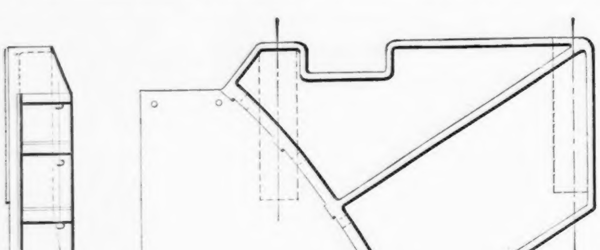


Fig. 2. Detail of Countershaft Bracket.

passes up to the countershaft on which are located the forward and return drives and two pulleys for tool feed. Directly underneath is a pit in which are the tight and loose pulleys for operating the planer bed. The machine has been in operation for over a year and works well. The bracket is very rigid and is at a sufficient elevation to allow the largest piece that can pass through the housing of the planer to pass under the cross belts which give the vertical and cross feeds. The bracket is about 6 feet long and the countershaft sets about 16 feet above the floor.

EDWARD BALBACH.

Dayton, Ohio.

USING DECIMAL EQUIVALENTS INSTEAD OF COMMON FRACTIONS.

It seems to be the general impression that it is easier and quicker to use the decimal equivalent of a fraction, instead of the fraction itself, when engaged in any calculations where the quantities occurring have to be multiplied or divided. There are very few cases, however, where the calculation can be made simpler by this substitution, and the results obtained are invariably less correct, because all the decimals which are necessary to correctly express the value of the fraction are as a rule not used, and when multiplying, an original error in the decimal equivalent substituted, of only one-half or one-quarter of one-thousandth inch, may finally amount to so many thousandths as to cause serious errors in close work.

An example which will plainly illustrate this assertion, and vindicate the position taken, may be found in the article "Jack Makes a Formula" in the December issue of MACHINERY. "Jack" writes his formula with figures substituted for the letters

$$R = \frac{0.687^2 + (1.5 - 0.75)1.5}{2(0.687 - 0.375)}$$

Proceeding he finds

$$R = \frac{0.472 + 1.125}{0.624} = \frac{1.597}{0.624} = 2.559.$$

If instead of using decimal equivalents for the fraction originally given in the problem we use the fractions themselves, we would write

$$R = \frac{\left(\frac{11}{16}\right)^2 + \left(1\frac{1}{2} - \frac{3}{4}\right)1\frac{1}{2}}{2\left(\frac{11}{16} - \frac{3}{8}\right)}$$

Simplifying this expression we find

$$R = \frac{\frac{121}{256} + 1\frac{1}{8}}{\frac{5}{8}} = \frac{\frac{121}{32} + 9}{5} = \frac{409}{160} = 2.556$$

We notice in the first place that "Jack's" denominator 0.624 ought to have been 0.625 or 5/8, and further, the final result shows a difference of 0.003 inch, which is enough to spoil many a job which may not even be required to be of extreme accuracy. This error is all due to the seemingly small original error of writing 0.687 instead of 0.6875.

Whenever there are no special reasons for using the decimal equivalent for a common fraction, the use of the fraction itself for calculations will always insure a correct result, besides usually decreasing the number of figures necessary to handle. Both draftsmen and machinists are always very eager to substitute the equivalents. If they would accustom themselves to using the fractions directly there would be fewer cases in the shop of deviation between the figured result and the measured. There is no good reason for substitution, and probably the only reason that can be advanced is that figuring with decimal fractions resembles the figuring with whole numbers, and consequently is easier. The actual amount of work, however, is usually increased, and accuracy is sacrificed for convenience.

R. S.

* * *

GRAPHITE SUGGESTED IN PLACE OF CHARCOAL.

In the January issue of MACHINERY Mr. U. Peters describes a method of coating iron with copper. We suggest that inasmuch as graphite can be powdered more finely than charcoal and that it lies closer to the metal, thereby making a much better coating, it might prove to be far superior to powdered charcoal in the process mentioned by him.

THE JOSEPH DIXON CRUCIBLE CO.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

DRIVING SCREW EYES.

The best way of which I know to drive or remove screw eyes, screw hooks, or the like, is the ordinary brace, and especially one made for the German flat-shanked bits. They drive straight and hard. ROBERT GRIMSHAW.

Hanover, Germany.

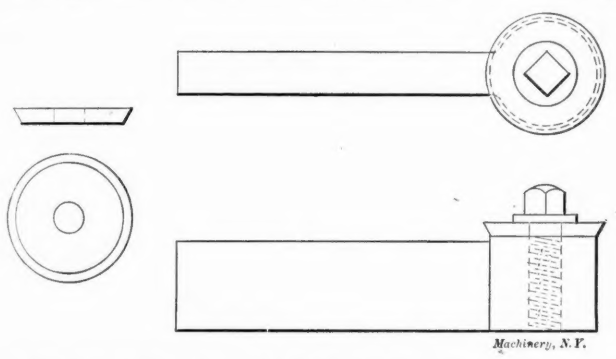
PEEP HOLES FOR ANNEALING FURNACES.

No annealing furnace should be unprovided with suitably placed peep-holes, properly protected with mica; for although the eye can by no means determine the temperature of the work with sufficient accuracy to be depended upon alone, yet a comparative observation can be made and the observer can readily tell if some pieces are in danger of being overheated, while others on the contrary have not yet got hot enough. Where there are peep-holes, and they are properly made use of, the amount of unequally heated and cracked pieces will be materially diminished. ROBERT GRIMSHAW.

Hanover, Germany.

RADIUS TURNING TOOL.

The cut below shows a simple radius turning tool and holder. The side view shows the cutter with a setscrew holding same in position, and clamping it to the body. The tool must be slightly larger than the circular part of the holder so as to give some clearance. The circular end of the body

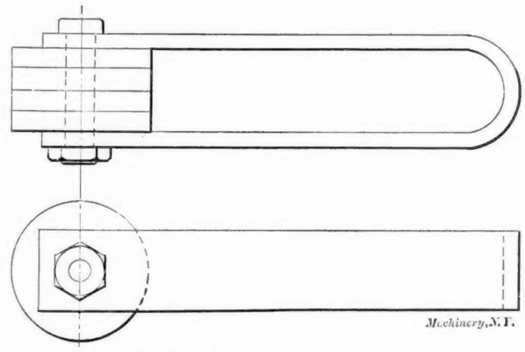


adds greatly to the strength of the tool and is also a preventative of chattering. In the detail of the cutter the clearance is shown exaggerated. These cutters may be turned, drilled and cut from a tool steel bar while held in a chuck. They are then hardened and the cutting surface ground.

Covington, Ky. FRANK LANG.

EMERY WHEEL DRESSER.

The cut below shows a simple emery wheel dresser made from an ordinary bent piece of band iron with four or five tool steel washers between the ends. A small bolt passes through the washers and the band iron holding it together. If the

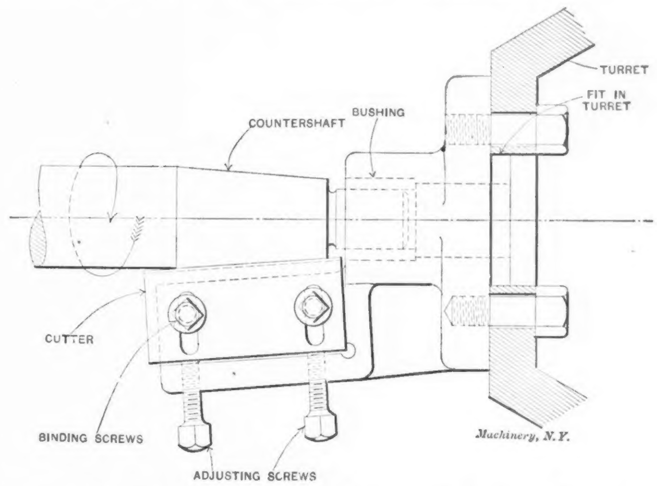


wheels of an ordinary dresser are worn out ordinary tool steel washers may be inserted as these will last just as long and are a great deal cheaper than the wheels bought especially for the purpose. ROY B. DEMMING.

Geneva, N. Y.

TURRET TOOL FOR CUTTING TAPERS IN THE SCREW MACHINE.

The cut herewith shows the way in which I recently machined the taper on 250 automobile countershafts. The tool

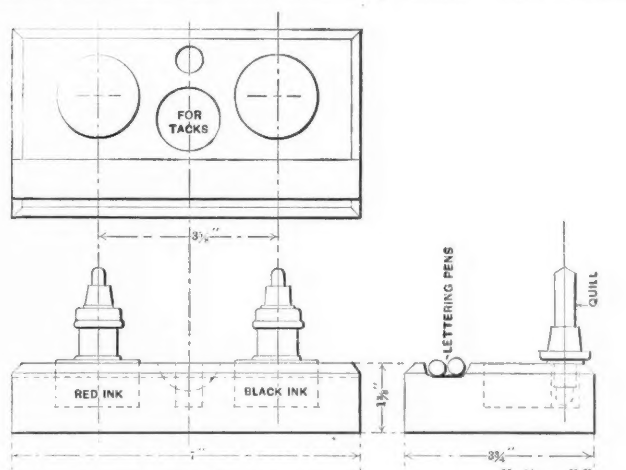


gave good satisfaction. It can be adjusted to almost any taper desired. C. W. PUTNAM.

New York City.

SAFEGUARD FOR INK BOTTLES.

In the December issue of MACHINERY, Mr. Lachmann writes about "A Simple Safeguard for Ink Bottles," which is all right, but could be improved upon without the use of mucilage. Taking the cardboard, describe a circle on it about ⅛ inch larger than the bottle, divide the circle into eight parts, draw lines from these points to within 3-16 inch of the center; then run your knife through those lines and lift up every other piece of paper to the edge of the circle and put an elastic band around the pieces just lifted up. This will form a wall around your bottle, while the pieces which stay down form a good base. Some readers will probably remember doing this in their school days. A better safeguard and a more substantial one is the one shown in the sketch; we use them in our office and find them very useful. Take a block



of wood about 3¾ x 7 inches and 1⅜ inch thick; have two holes bored in it part way, one at each end, to fit the ink bottles; also make a ½-inch hole for the quill; this will be found very convenient when lettering. Make a cup-shaped hole at a convenient place to put tacks into and on one side make a groove about ¾ inch wide to lay the lettering pens into; this completes our inkstand. It can be made at very small cost and gives a neat appearance. PETER PLANTINGA.

Worcester, Mass.

INKING ON TRACING CLOTH.

When using the smooth side of tracing cloth an excellent powdered preparation, necessarily applied before inking, is talc, which can be had for almost nothing, it being a fine sand powder used in core work. An old talcum powder box will serve the purpose of a sifter. CALVIN B. ROSS.

Springfield, O.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it provided it has not already appeared here.

296. FILLING FOR BLOW HOLES IN CAST IRON.

One part red lead, and 1½ part litharge. Mix with glycerine to consistency desired. E. H. McClintock.

West Somerville, Mass.

297. CLEANING THE POLISHED PARTS OF MACHINERY.

Stains of every description, such as may result from dried oil, etc., may be easily and effectively removed by the application of alcohol. Calvin B. Ross.

Springfield, O.

298. TO PREVENT THE STICKING OF HOT LEAD.

To prevent molten lead from sticking to the pot or the tools heated in it, cover the surface with a mixture of powdered charcoal, 1 quart; salt, ½ pint; yellow prussiate of potash, 1 gill; and cyanide of potassium a lump the size of a walnut.

Hardener.

299. BLACK VARNISH FOR METALS.

A good varnish for finishing metals can be made by mixing 1,000 parts of benzine, 300 parts of pulverized asphalt, and 6 parts of pure India rubber, to which is added enough lamp black to give the desired consistency to the mixture.

Bridgeport, Conn. H. A. Sherwood.

300. WATERPROOF CEMENTS.

To make a good waterproof cement in a thin paste form, dissolve 1 ounce powdered resin in 10 ounces strong ammonia and add 5 parts gelatine and 1 part solution of acid chromate of lime. For waterproof cement in paste form, add to hot starch paste one-half its weight of turpentine and a small piece of alum. T. E. O'Donnell.

Urbana, Ill.

301. TO CLEAN BRASS CASTINGS.

Brass work that has become dirty or corroded in service may be cleaned in the following wash: 1-3 part nitric acid, 2-3 part sulphuric acid, and ½ pound common salt to each 10 gallons of solution. Dip the castings in the solution for half a minute and then rinse in boiling water and dry in pine sawdust. E. W. Bowen.

Denver, Col.

302. PREPARATION FOR PRODUCING EXTREME HARDNESS IN STEEL.

The steel to be hardened should be immersed in a mixture of 4 parts of water, 2 parts of salt, and 1 part of flour. To get the steel thoroughly coated it should be slightly heated before dipping in the composition. After dipping, it is heated to a cherry red and plunged in soft water. This will make the steel harder than if simply heated and dipped in water.

S. C.

303. TO PRODUCE A GRAY COLOR ON BRASS.

First clean off with alcohol, polish the surface to an even finish, making sure that grease or finger marks are removed. Then immerse in a solution of one ounce of arsenic chloride to one pint of water until the desired color is obtained. Wash in clean, warm water, dry in boxwood sawdust, warm, lacquer with a thin pale solution of bleached shellac in methyl alcohol, using a broad camel's hair brush.

Middletown, N. Y. Donald A. Hampson.

304. NON-FLAKING WHITEWASH.

To prepare whitewash for fences, buildings, shop interiors, etc., that will not flake and fall off, mix 1 quart fine Portland cement with about 8 gallons whitewash. The cement binds the whitewash to the wood and makes a permanent covering which is unaffected by weather conditions. The small quantity of cement used and the constant stirring necessary to keep the whitewash in good condition for applying, prevents the cement hardening in lumps at the bottom of the pail, as might be expected. M. E. Canek.

305. BELT DRESSING.

The belt dressing recently recommended in Machinery—a mixture of 95 per cent of resin and 5 per cent of machine oil—is the second best compound of which I know for ruining either a rubber or a leather belt. (The first best is printers' ink.) Either of these will make a leather belt glazed and stiff, and will flake off the outer layer of any ordinary rubber ply belt. There is nothing better for leather belts than crude castor oil, applied hot. Nothing should be allowed to touch a rubber belt but hot soapsuds, or warm dilute potash or soda lye. Robert Grimshaw.

Hanover, Germany.

306. MIXING PLASTER-OF-PARIS.

Almost every one has to mix up gypsum or plaster-of-paris once in a while, but few know how to do it so as to make a smooth cream, or thin dough, without lumps. The trick is not to pour the water on the plaster, but to turn the latter gradually into the water, spreading it about in shaking it in, and to avoid stirring until all the plaster has been added. The proper quantity of gypsum is usually enough to peep out over the surface of the water over the greater part of the area; that is, about equal volumes of each ingredient. The addition of glue-water to the mixture retards setting.

Hanover, Germany. Robert Grimshaw.

307. COMPOSITION OF SPIRIT VARNISH.

The table below gives the composition in ounces of eight different kinds of varnish:

Sandarac	2	8	—	4	2	—	1	1
Best shellac	1	—	5	2	5	10	5	4
Mastic	½	—	—	1	—	2	1	1
Benzoin	—	—	—	1	—	—	1	1
Powdered glass	1	—	—	4	5	—	—	—
Venice turpentine	1	2	1	2	2	—	—	1
Elemi	½	—	—	—	1½	—	—	—
Alcohol	6	32	32	32	24	32	32	32

Varnish can be "paled" by adding 2 drachms of oxalic acid per pint of varnish; it can be colored red with dragons blood, brown with logwood or madder, and yellow with aloes or gamboge, each dissolved in spirits and strained.

Birmingham, England. W. R. Bowers.

308. IMPROVED SOLDERING ACID.

A very satisfactory soldering acid may be made by the use of the ordinary soldering acid for the base and introducing a certain proportion of chloride of tin and sal-ammoniac. This gives an acid which is far superior to the old form. To make one gallon of this soldering fluid, take three quarts of common muriatic acid and dissolve as much zinc as possible in it. This, as is well known, is the common form of acid used in soldering. Next dissolve 6 ounces of sal-ammoniac in a pint of warm water. In another pint dissolve 4 ounces of chloride of tin. The three solutions should then be mixed together. After mixing, the solution may appear cloudy, and can be cleared up by a few drops of muriatic acid, care being taken not to add too much. The acid is used in the same manner as any ordinary soldering fluid. It will be found that it will not spatter when the hot iron is applied, and also that a cheaper grade of solder may be used with it, if necessary.

Urbana, Ill. T. E. O'Donnell.

309. WATERPROOFING BLUEPRINTS.

To prevent the annoyance occasioned by having blueprints discolored by rain, drippings of mines or other similar exposures, a very simple method of waterproofing them may be effected as follows. The waterproofing medium is refined paraffine. To apply, immerse in the melted paraffine, until saturated, a number of pieces of an absorbent cloth at least a foot square. When withdrawn and allowed to drain for a few moments they are ready for use. Lay one of the saturated sheets on a smooth surface, place the dry print on top of it, and then lay a second sheet of the saturated cloth over it. Iron the top cloth with a moderately hot flat iron. The paper immediately absorbs the paraffine until saturated, becomes translucent and highly waterproofed, owing to the smooth glossy surface, which is the result of the ironing. The lines of the print will be intensified, and the paper left perfectly smooth and easy to handle. T. E. O'Donnell.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

The concluding part of the answer to the first question in How and Why, January issue, should be corrected to read as follows:

$$\text{Tan } a_1 = \frac{\frac{1}{8}}{12} \times \cos 45 \text{ degrees} = \frac{\frac{1}{8} \times 0.707}{12} = 0.00736,$$

the tangent of the required angle or 25 minutes. The result given (25 minutes) was correct but the omission of multiplication by 0.707 made it apparently wrong.

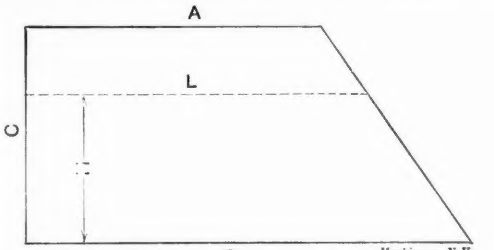
M. F. P.—What is meant by the "saturation point"? For example, some shop receipts say dissolve zinc in muriatic acid to saturation in order to make tinner's acid.

A.—A saturated solution is one that has absorbed all of a solid substance that it can carry in suspension. For example, cold water will dissolve a certain quantity of salt and when it has absorbed all that it can carry in suspension it has reached the saturation point; when the water is hot a larger quantity of salt would be dissolved so that we say the saturation point of hot water is higher than that of cold water. In making tinner's acid we simply put in a greater amount of zinc into the muriatic acid than the acid can dissolve, and thus assure the fact that we have a saturated solution; that is, one which carries all the muriate of zinc that it can hold in suspension.

Rusticus.—Will you kindly give me some rule or formula for dividing a trapezoid, by drawing lines parallel to the base, into three figures of equal area?

A.—This problem is best approached by deriving a general formula for cutting off, by drawing a line parallel with the base, an area equal to a given percentage of the whole area. Such a formula can be obtained as follows:

Let A, B and C be the dimensions shown in the diagram; let p be the decimal expressing the proportion of the whole diagram it is desired to cut off by a horizontal line parallel with the base, this percentage to be represented by the area below the line. L is the length and H the distance from the base of a line drawn to meet the given conditions. From an inspection of the figures we get the equation:



Trapezoid to be Divided.

$$\frac{H}{2}(B + L) = \frac{pC}{2}(B + A). \qquad (1)$$

This simply expresses the condition that the area below the line is p per cent of the total area of the figure, these areas being obtained by multiplying the sum of the upper and lower bases by half the altitude, according to the usual fashion. Inspecting the diagram again, we may form the second equation:

$$(B - L) : (B - A) = H : C, \qquad (2)$$

which expresses a condition so obvious that it need not be explained. Solving this second equation for L, we obtain the following:

$$L = B - \frac{H}{C}(B - A). \qquad (3)$$

Multiplying by 2 both sides of Equation 1 and inserting the value of L obtained in Equation 3, we have as a result:

$$2BH - \frac{H^2}{C}(B - A) = pC(B + A). \qquad (4)$$

This equation rearranged and solved for H gives us

$$H = \frac{C}{B - A}\left[B - \sqrt{B^2 - p(B^2 - A^2)}\right]. \qquad (5)$$

Having derived this formula, its use in the problem proposed by our correspondent is simple. If two lines are drawn parallel to the base dividing the trapezoid into three figures having equal areas, the lower line will include between itself and the base an area equal to 1/3 of the total area of the figure, while the second line will include between itself and the base an area equal to 2/3 of the whole area. Solving the formula of Equation 5 for $p = 1/3$ and $p = 2/3$ in turn, we get two values for H^1 which give the heights at which the first and second lines respectively are to be drawn.

It will be understood that the trapezoid need not necessarily have one of the sides perpendicular to the base, as shown in the cut. The formula may be used for any quadrilateral having two parallel sides A and B, when C is the perpendicular distance between them.

Jeweler.—I would appreciate some information that would enable me to make laps for finishing jeweler's rolls which will remain true. My present practice of charging laps produces uneven charging and the laps soon wear out of round, thus making the rolls uneven in finish. These rolls have to be very exact and smooth, as they are used for rolling gold-filled stock which cannot be finished afterward except by buffing.

Answered by Frank E. Shailor, Great Barrington, Mass.

A.—It is impossible to charge any lap so that it will remain evenly charged if the lap is used in such a manner that will cause it to become out of round. Judging from the correspondent's inquiry, I infer that the lap is held against the roll and is not moved back and forth. This will cause it to "strip," and, of course, the lap then transfers its uneven surface to the roll. When the jeweler's rolls are ground preparatory to lapping, they are relatively speaking, quite uneven and rough; therefore, if a lap is unevenly charged and is perfectly round the high spots on the roll will soon wear minute ridges in the lap, provided that the lap is held in one position and dependence placed on the lap to true the roll. I would suggest the following method and will add that it is the best known method among fine toolmakers:

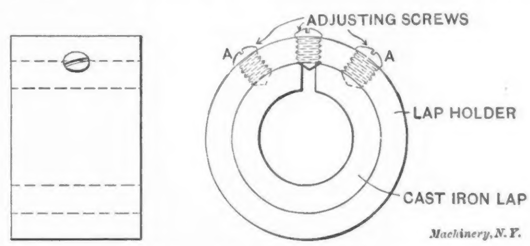


Fig. 1. Lap and Lap Holder.

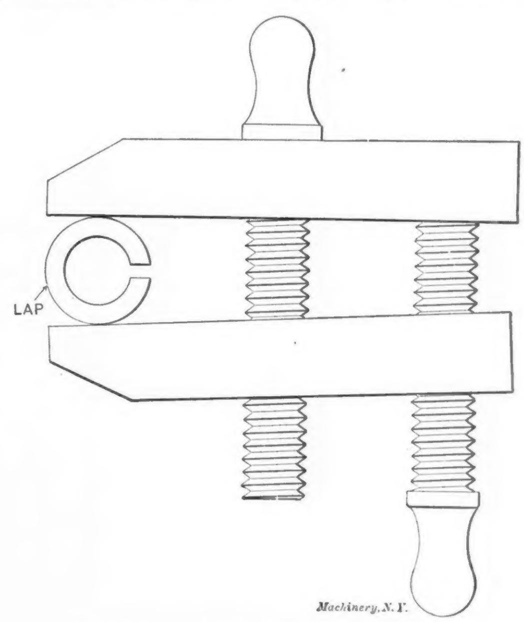


Fig. 2. Wooden Clamp used as Lap Holder.

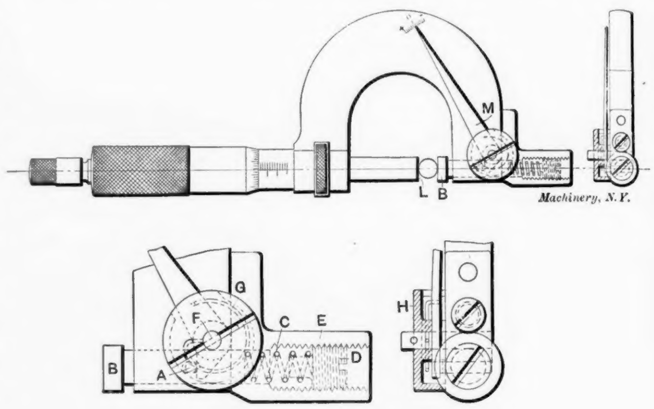
The rolls must be ground true and straight with their axes.

Particular attention must be paid to making the rolls straight before commencing to lap. The roll is gripped in a lathe chuck by its shaft and a lap of cast iron, copper or brass, such as shown in the accompanying cut, should be employed. The lap is smoothly bored or reamed to the same size as the roll to be finished, and slotted and held as in Fig. 1. The screws *A A* are provided for adjustment to compensate for wear. A wooden clamp, Fig. 2, may be employed instead of the ring lap-holder. Flour emery that has been sifted through a thick cloth bag and mixed with lard oil to a consistency of a thin paste makes an excellent abrasive for lapping. The roll is revolved and smeared with the emery paste and speeded as fast as it can run without causing the emery to fly off the roll. The lap should now be moved back and forth on the roll and kept constantly in motion, for if allowed to dwell an instant in one place it will produce ridges in the roll. The reason for this is that the emery varies slightly in size and cutting power. While it is possible to charge a lap fairly true, one cannot depend upon even cutting, therefore it is absolutely necessary that the lap be kept constantly in motion and frequently adjusted to prevent it wearing larger than the roll. The cause of a lap wearing out of round is due to lack of care in not keeping it adjusted snugly to the roll. *The lap must fit the roll snugly all the time while lapping.* Another essential point to be heeded is that the lap must be kept well moistened, especially if diamond dust is used. Diamond dust, while more expensive than emery, cuts much faster, but if the lap is run dry for an instant the small particles of diamond that are merely forced into the lap are called upon to extend more pressure than they are capable of withstanding. The consequence is that a piece of diamond will break away and back against the next particle, and so on, and in an instant the lap is "stripped." Kerosene is an excellent lubricant for diamond dust lapping. Another essential point that must be heeded is that the ends or corners of the roll will round slightly, the same being the case when lapping out a hole; the hole will become "bell muzzled." The best way to overcome this difficulty on the roll is to make the lapping ring or roll travel further than the required length, and then grind to the proper length after lapping. The width of the lap should be at least one-third the length of the piece to be lapped. Rolls that have become rust eaten must be ground true before they can be lapped, for the abrasive will lodge in the rust spots and will quickly cut ridges in the lap. Rolls that have become hollow from long usage can be trued with a lap, but it requires much skill both in handling the lap and in the use of micrometers, by which the straightness of the roll is determined. The point to be fully understood is that for very accurate work one can never depend on the truth of a lap, for no matter how evenly charged it is, it will have keener cutting points in one place than another, hence the necessity of keeping it constantly in motion so as to distribute the cutting action evenly over the whole surface of the roll.

* * *

SENSITIVE MICROMETER ATTACHMENT.

When testing the diameters of pieces that are handled in great quantities and are all supposed to be within certain close limits of a standard dimension, the ordinary micrometer presents the difficulty of having to be moved for each piece, and small variations in diameters have to be carefully read off from the graduations on the barrel. Not only does this take a comparatively long time but it also easily happens that the differences from the standard diameter are not carefully noted and pieces are liable to pass inspection that would not pass if a convenient arrangement for reading off the differences were at hand. The accompanying cut shows a regular Brown & Sharpe micrometer fitted with a sensitive arrangement for testing and inspecting the diameters of pieces which must be within certain close limits of variation. The addition to the ordinary micrometer is all at the anvil end of the instrument. The anvil itself is loose and consists of a plunger *B*, held in place by a small pin *A*. The pin has freedom to move in a slot in the micrometer body, as shown in the enlarged view in the cut. A spring *C* holds the plunger *B* up against the work to be measured and a screw *D* is provided for obtaining the proper tension in the spring. The screw and the spring are contained in an extension *E* screwed and dowelled to the body of the micrometer. A pointer or indicator is provided which is pivoted at *F* and has one extensional arm resting against the pin *A*, which is pointed in order to secure a line contact. At the end of the indicator a small scale is graduated with the zero mark in the center, and as the indicator swings to one side or the other the variations in the size of the piece measured are easily determined. A small spring *G* is provided for holding the pointer up against the pin *A*. The case *H* simply serves the purpose of protecting the spring mentioned. As the plunger *B* takes up more space than the regular anvil the readings of the micrometer cannot be direct. The plunger *B* can be made of such dimensions, however, that 0.100 inch deducted from the barrel and thimble reading will give the actual dimension. Such a deduction is easily done in all cases. In



Sensitive Micrometer Attachment.

other words, the reading of the micrometer should be 0.100 when the face of the measuring screw is in contact with the face of the plunger; the 0.100 inch mark is thus the zero of this measuring tool.

When wanting to measure a number of pieces, a standard size piece or gage is placed between the plunger *B* and the face *L* of the micrometer screw and the instrument is adjusted until the indicator points eactly to zero on the small scale provided on the body of the micrometer. After this the micrometer is locked and the pieces to be measured are pushed one after another between the face *L* and the plunger *B*, the indications of the pointer *M* being meanwhile observed. Whenever the pointer shows too great a difference the piece of course does not pass inspection. All deviations are easily detected, and any person of ordinary common sense can be employed for inspecting the work.

* * *

One of the very necessary little things in the make-up of a publication is the "filler." What is a filler? Simply an idea or bit of information expressed in a number of lines that just happens to fill the yawning gap between the end of some article and the foot of the page. In fact probably this will be used as one. The make-up editor treasures his fillers, arranging and re-arranging the make-up—whisper it softly—to suit the fillers, oftentimes. In time of stress he is sometimes known to use the shears on a contemporary and lift bodily some item that happens to fill an aching void. Who can blame him if, in his hurry, he sometimes forgets to acknowledge the source of his salvation? But it is nevertheless amusing and sometimes the least bit irritating to see an item, on which we have spent our valuable time "writing and rewriting, polishing and repolishing," going the rounds of the press, a lone orphan, the sport of fortune and anything else pitiable that the reader can think of. But to get down to what we started out to say: In the October, 1905, issue a note was published in MACHINERY on the relative strength of grindstones when wet and dry, being an abstract of a report published on investigations made in the Sheffield district, England. The item has since floated around through many of the trade papers, and the last seen of it was in the *Journal of the Franklin Institute*, credited to the *Iron Age!* So at last, this poor lone note has found place and position—embalmed as it were with the odor of respectability. It is well!

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

A GEAR-DRIVEN UNIVERSAL MILLER.

In the December, 1905, issue of MACHINERY we illustrated and described a gear-driven Milwaukee plain milling machine. The builders of this machine, the Kearney & Trecker Co., Milwaukee, Wis., have now re-designed their universal machines along the same lines, and they propose to give up the building of the cone-driven style entirely, having evidently the courage of their convictions as to the superiority of the single pulley and gear-driven type. Besides this matter of drive, and the general stiffness and weight of the machine,

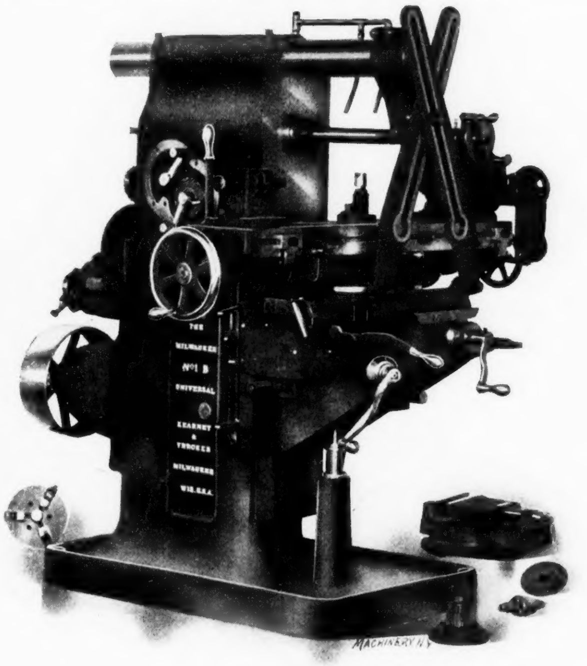


Fig. 1. Milwaukee Gear-driven Universal Milling Machine.

there are other details of design which show that the builders believe there is a demand for a machine fitted with the best of conveniences for effective service, even when these conveniences add considerably to the expense of building the machine. For instance, elaborate provision is made for lubricating the gears and journals of the spindle driving and feed mechanism. Near the base of the machine in Fig. 2 will be seen a funnel and a drain cup leading to a reservoir for lubricating oil. A circulating pump connected to the driving shaft, and running even when the spindle is motionless, carries the oil from this reservoir to every point where it is needed for the mechanism within the column. The oil used in this way returns by gravity to the reservoir, and is again pumped back. From time to time a sample of the oil may be drawn off through the valve, and its condition noted. If it is dark with considerable dirt and mineral in suspension, it should be filtered, after which it is again ready for use. Besides this provision for circulating the lubricating oil, a second reservoir is provided for cutting oil. A tank for this is reached through the door in the side of the column shown in Fig. 1. A second pump takes the liquid from this tank, forces it through the pipes and flexible tubing over the spindle onto the revolving cutters. A carefully arranged series of screens, drains, and cored passages leads the oil from the table through telescopic tubing from the saddle to the base of the column, as shown in Fig. 2, and back to the reservoir again. This pump is not an attachment furnished at an extra cost, but is invariably included in the equipment. A universal miller, engaged in the work for which it is best suited, is working on machine or tool steel the greater part of the time, and on this work a good lubricant should always be used. The arrangements provided are fitted to use this lubricant in the most effective way. The makers advise that the best grade of lard oil be employed, as this, in the long run, has proven to be the cheapest and most satisfactory.

Aside from the universal features of the machine, the general design is similar to that of the plain miller previously described. In Fig. 1 a vertical lever may be seen, pivoted in the column and showing just back of the tailstock spindle on the work table. This lever is used for starting and stopping the machine independently of a countershaft. As usually arranged, the driving pulley is belted directly from the lineshaft. This makes it possible to get a new machine into operation very quickly, and does away with the troublesome features of friction pulleys and elaborate overhead works. When a motor drive is wanted, it is substituted in place of the pulley bracket, and the resulting combination has a very pleasing and harmonious appearance. The 18 speed changes are obtained entirely by gearing. The two cranks seen at the side of the column, back of the starting and stopping lever, provide for this. The upper one has three positions, and the lower one has six. This combination gives the 18 spindle speeds, with a range of from 15 to 354 revolutions per minute in increments of 20 per cent. While it is entirely possible to change the speed with the machine running, it is not considered feasible or necessary, as the frequency with which changes of speed are required in milling machines is much less than in lathes, for instance, used in turning different diameters. A miller set up for a job uses the same sized cutter, which is not changed until the machine is set up for another job; besides the starting lever is easy to reach at any time when it may be desired to stop the machine. An index plate is provided showing the speeds obtainable. A hand wheel at the rear of the column just under the spindle

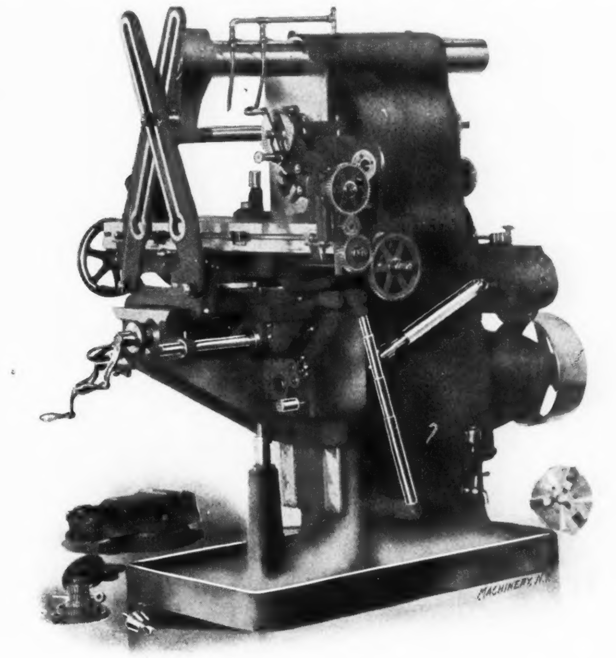


Fig. 2. Right-hand Side of Universal Miller, showing Oiling Arrangement and Spiral Head.

is partially shown in both cuts. This is used to turn the spindle by hand through small angular movements when this is necessary. The spindle is provided with a hardened collar for driving the cutter arbor, and with a draw-in bar to hold the arbor in place and force it out again.

The feed change levers, which may be seen at the rear of the machine in Fig. 2, operate a mechanism similar to that used in changing the spindle speeds. Ten changes are available, giving feeds of from 0.55 to 16.0 inch per minute, the feed per minute in all cases being independent of the spindle speed. In combination with the changes of spindle speed on this size machine, from 0.001 to 1.066 inch feed per revolution of spindle is obtainable. Automatic vertical and longitudinal feeds are regularly supplied on all the machines whether ordered or not, and positive automatic stops are provided at the limits of

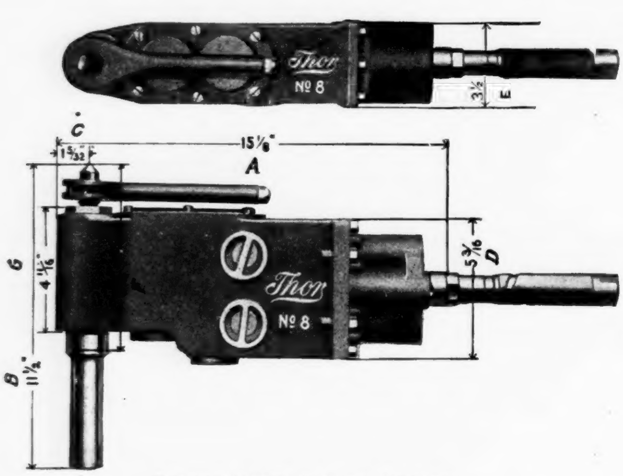
the movement of all feeds to prevent accident. Adjustable stops are also supplied to trip the feed at any point desired. The fixed stops are immovable so that the operator cannot accidentally hit them. The arrangement of the feed controlling levers makes it impossible to engage two feeds at the same time.

The table is made to swivel in the manner common to all universal milling machines, but modified in such a way as not to interfere with the return of the lard oil or other lubricant from the table to the reservoir in the closet of the machine. Ball bearings are provided to take the thrust of cross table and elevating screws. The three-jaw universal milling machine chuck used with the spiral head has reversible jaws. This is a departure from the usual practice, but it is thought to be justified, as the old fashioned milling machine chuck only permits the holding of work of comparatively small diameters, whereas it is often convenient to hold pieces of widely varying character in the chuck. Many of the features found useful in the cone pulley millers have been incorporated in the design of the new machines. For example, the extended knee slide of the column was carried above the spindle bearing primarily to furnish a convenient place for clamping the vertical spindle and other attachments, and incidentally to add to the stiffness of the spindle bearing. This last advantage is not so apparent in the new machines, as it will be seen that the box form of frame, without an opening for the cone pulley, leaves nothing further to be desired in the matter of stiffness of the column itself.

The cuts show the No. 1 B, the smallest of three sizes, all of which are uniform in design.

A PNEUMATIC DRILL FOR CLOSE QUARTERS.

The Independent Pneumatic Tool Co., of Chicago and New York, have recently perfected a machine designed as their "Thor" No. 8 close quarter piston air drill which, as may be seen in the accompanying cuts, is especially suited for drilling in close quarters and in corners where the ordinary drill can not be used. The device is capable of drilling holes up to $2\frac{1}{2}$ inches in diameter in any ordinary metal. It has no delicate



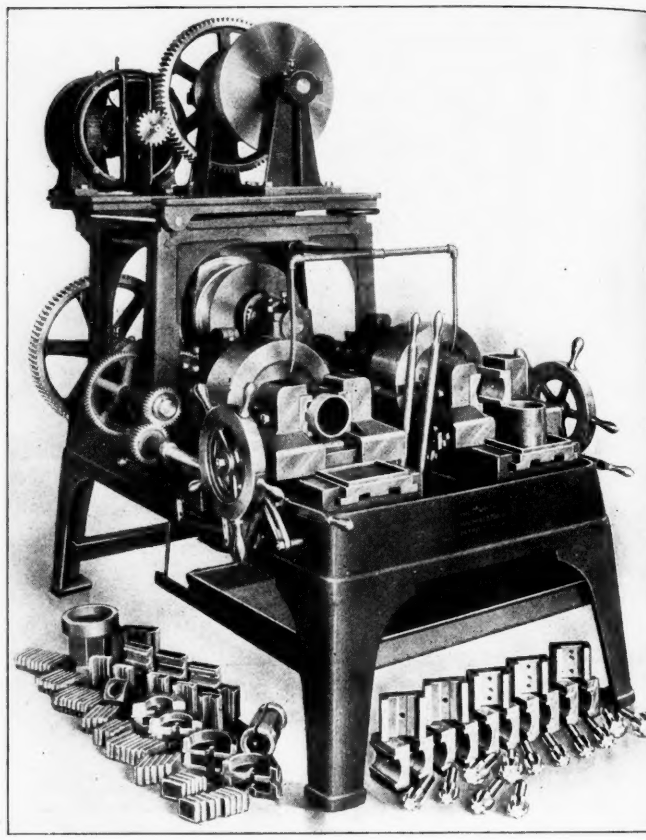
Pneumatic Drill for Close Quarters.

mechanism and is very easily handled and operated. The principal dimensions are shown on the cut, and its compactness will at once be appreciated. The makers state that they will send this drill on approval to any one desiring to make a test of it.

THE MURCHEY DOUBLE-HEAD NIPPLE AND PIPE THREADING MACHINE.

The Murchey Machine & Tool Co., corner 4th and Porter Streets, Detroit, Mich., in the design of their double head pipe threading machine, have provided sufficient power to thread two 4-inch pipes simultaneously. The cut shows a motor-driven machine, but it can be arranged to be belt-driven if desired. The die heads of the machine have steel bodies and are of an entirely new design. There are six chasers in each, rigidly held in radial slots by a face ring. The head is in two parts and opens automatically, by the action of the reamer coming in contact with the end of the pipe when the thread has reached its proper length. The processes of reaming and threading are performed in this machine at the same operation, and by making the opening of the dies depend on the contact of the reamer with the work, perfectly reamed pipes and uniform lengths of threads can be obtained regardless of the position of the pipe in the vise. There is a separate reamer furnished for every size pipe within the range of the machine. The unusual bearing surfaces of the vise jaws adapt the machine especially to the threading of very short nipples.

Another important improvement is the lead screw attachment furnished as part of the machine. With this arrangement, instead of starting the cut by hand, the operator simply clasps the pipe in the vise jaws and throws in the lead screw, no further attention being required. The same thing is done



Murchey Double-head Nipple and Pipe Threading Machine.

for the other head of the machine. The first thread has meanwhile reached its proper length, the end has been reamed, the dies have opened automatically, and the lead screw has been released. The mechanism, for effecting the simultaneous release of the lead screw and opening of the die head is extremely simple, though positive and effective, no special care being required in adjusting it. Great care has been taken to make every detail of the machine as nearly fool-proof as possible.

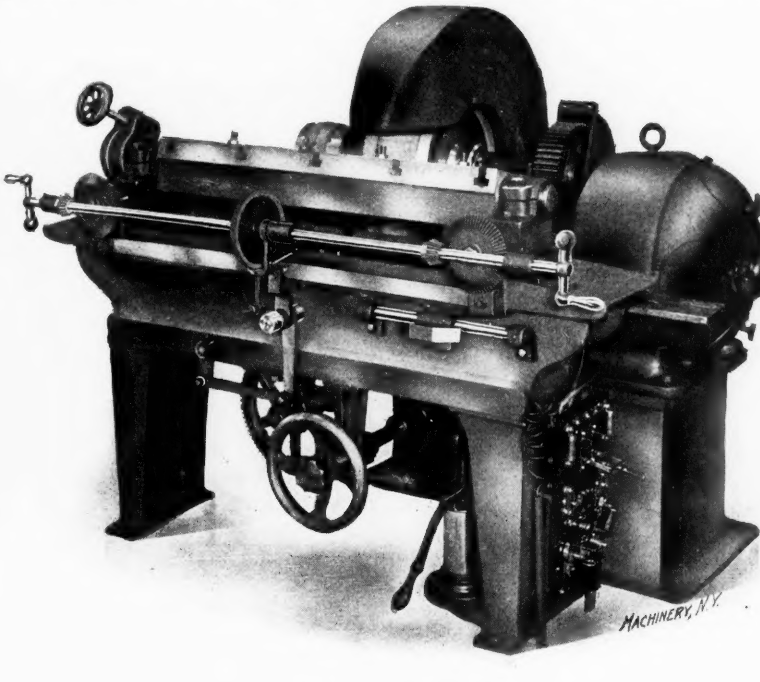
The cone pulley has three steps with diameters from 12 to 16 inches for a $3\frac{1}{2}$-inch belt. With one change by gearing, this gives six different speeds; with the back gears thrown in for heavy work the gear ratio is 25 to 1. The motor shown attached to the machine is of $3\frac{1}{2}$ horsepower and is furnished by the Triumph Electric Co. of Cincinnati. The makers of this machine claim that it will easily produce 700 four-inch threads in ten hours.

THE BRIDGEPORT MOTOR-DRIVEN KNIFE GRINDER.

Among the improvements introduced by the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn., in the knife grinder shown herewith, are, the use of a motor-driven wheel, an improved method of knife support and feed works, and carefully arranged provisions for supplying the wheel with water and returning it to the tank after use.

The knife which is being ground is clamped to a hollow, square knife bar or support of great strength and stiffness. The bolts which hold the knife to this bar pass entirely

through it, and so are easily inserted and removed. This work support is pivoted at the ends to the two sliding bearings, thus furnishing a means for grinding the edge to any angle desired, the adjustment for this being obtained by a worm and wheel arrangement operated by the hand wheel shown at the left of the work table. A graduated index shows the angle obtained. The sliding bearings in which the work



A Motor-driven Knife Grinder.

support is pivoted are moved forward simultaneously by feed screws geared to move together, under the influence of the longitudinal shaft shown at the front of the table. Provision is made for clamping the work in approximately the correct position, and adjusting it afterward so that the wheel will grind the same amount from each end. This is done by slipping one of the bevel gears on the horizontal feed shaft out of mesh with its mating gear, when one bearing may be adjusted out and in by the feed crank while the other remains stationary.

An automatic traverse is given to the table, its motion being determined by the adjustable dogs shown, which act in the same way that the stops on a planer table do. The work is fed in automatically at the end of a stroke by the action of a double wedge, adjustably mounted on the round bar support shown at the right hand end of the bed. This acts on a swinging lever pivoted by the feed shaft, operating a ratchet wheel attached to it. The feed thus obtained may be adjusted to give the work as fine an advance as 0.001 inch for each traverse of the carriage. The carriage drive is strongly back geared and all the gears are cut from the solid. The carriage runs on a wide flat track with the outer edges gibbed under the bed to hold it securely in alignment, and is provided with side adjustment for wear in that direction. It is thus impossible to force the carriage off the ways if the wheel is forced against the work. The carriage is so constructed as to cover the sliding surface of the bed while in action.

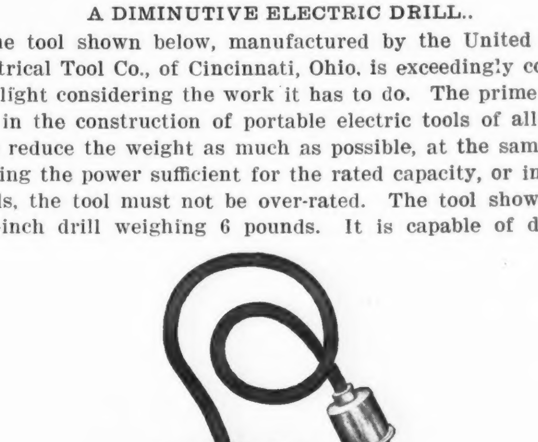
The emery wheel is set on a back extension of the bed of the machine in a mounting so arranged that when the wheel is partially worn out it may be set forward to use the remainder. This extension on which the wheel is mounted is utilized also for a water compartment. A patented air pump mechanism forces the water from the lower tank into the upper compartment under the wheel. Suitable guards and pans catch the drip from the knife bar and carriage, and conduct it back to the reservoir. This use of water prevents the glazing and heating of any portion, and obviates the danger to the wearing surfaces of the machine from emery dust flying about loosely in the air. This tool, known as the improved medium weight knife grinder, is made in four sizes for traverse of 32, 42, 52, and 62 inches, either belt- or motor-driven. The emery wheel shown is 26 inches in diameter by 1½ inch wide.

THE FEDERAL BLUEPRINTING MACHINE.

The Keuffel & Esser Co., 127 Fulton Street, New York, announce their purchase of the patent rights to the Federal blueprinting machine. Among the points of superiority claimed for this device over other machines of the same kind are: The effective use of the intense light furnished, thus making continuous printing possible at nearly as high rate of speed as possible with the most favorable sunlight; the continuous action which obviates loss of time in preparing the apparatus for each separate exposure; the absence of glass or other fragile material in the machine; and the extreme ease of manipulation, no handling of heavy parts being required. The device consists essentially of a large drum mounted in roller bearings, an apron of transparent material for getting smooth contact between the drawing and the blueprinting paper, a reflector containing electric lamps, a small electric motor, a speed controlling device, and an arrangement for regulating the tension upon the apron. The fact that the work is fed and discharged on the same side of the machine saves a great deal of time, and a further advantage is that the operator is able at all times to examine the prints coming from the exposing chamber and to vary the speed of travel as may be required. The device is made in three sizes for prints up to 30, 42, or 54 inches wide, and is equipped with respectively 4, 6, or 8 lamps. The height of the machine from the floor to the top of the lamps is 4 feet 10 inches. Its depth is 4 feet 6 inches, and the width of the three sizes is respectively 4, 6, and 10 feet.

A DIMINUTIVE ELECTRIC DRILL.

The tool shown below, manufactured by the United States Electrical Tool Co., of Cincinnati, Ohio, is exceedingly compact and light considering the work it has to do. The prime necessity in the construction of portable electric tools of all kinds is to reduce the weight as much as possible, at the same time keeping the power sufficient for the rated capacity, or in other words, the tool must not be over-rated. The tool shown is a 3/16-inch drill weighing 6 pounds. It is capable of drilling



A Small Drill, built by the United States Electrical Tool Co.

holes of up to the size mentioned in wood, iron or steel and the motor will easily develop ¼ horsepower. It is especially suited for such work as drilling holes for oil, nameplate screws, etc., in the machine shop. Extra handles of various patterns are supplied when necessary, making the tool a useful one for many different operations.

A HEAVY TOLEDO STAMPING PRESS.

The modern tendency toward increase in the range of work required of stamping presses, and other machinery of the same type, is well illustrated by the line cuts of the work shown in Fig. 2, and the halftone of the massive machine used in producing them, as shown in Fig. 1. While with hydraulic presses and red hot stock to work on, the operations indicated would be common everyday affairs, when it comes to

the question of performing them on cold stock in belt-driven machines, the task is one of unusual magnitude. The builders, the Toledo Machine & Tool Co., Toledo, Ohio, believe this press to be the largest and most powerful one of the kind in operation in this country.

The first stamping, of ¼-inch steel plate, is made from a 20-inch blank. This piece is formed and the center opening cut out and flanged in two operations. The second sample is made of plate ½ inch thick. The center opening was cut and

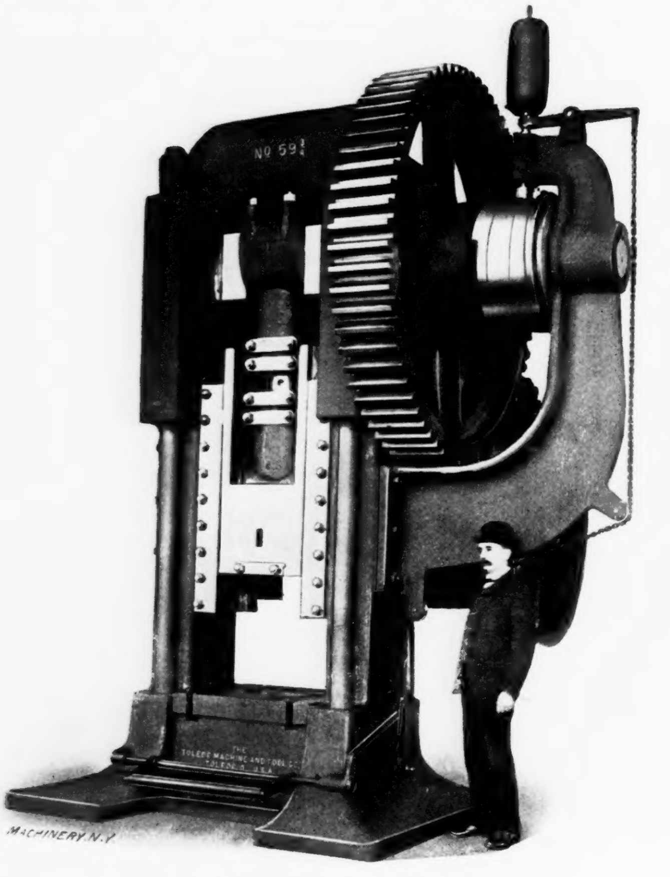


Fig. 1. Stamping Press of Unusual Size.

flanged in three operations, the flange being about 2 inches high. This work was performed on the special press shown, designed and built for the Crosby Company of Buffalo, who make a specialty of producing stampings of this character for a wide range of work.

Some idea of the size of the machine may be obtained from the following measurements. The frame, which is of cast iron and made in one piece, weighs 42,800 pounds and has a capacity of resisting a pressure of 1,200 tons. The distance

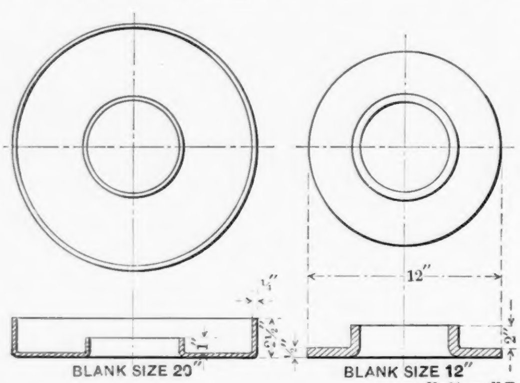


Fig. 2. Samples of Work, Stamped Cold in the Machine shown above.

from the bed to the slide, with stroke and adjustment up, is 31 inches. The diameter of the crankshaft at the crank bearing is 13 inches, and the stroke is 14 inches. The gearing is in the ratio of 40 to 1, and the main gear is 14 inches face by 92 inches in diameter, and weighs 9,000 pounds. The 60-inch flywheel weighs 2,400 pounds. The total height of the machine to the top of the large gear is 14 feet 8 inches, and the total weight is 100,000 pounds.

CHASING ATTACHMENT FOR THE FLAT TURRET LATHE.

In determining what work should be done in the engine lathe and what in the turret lathe, there has always been one field in which the older machine has still kept the advantage. When short threads of large diameters are called for, where accuracy, both of size and alignment, is required, the necessary operations are performed on the engine lathe, with the usual change gear and lead screw apparatus. Various devices have been tried on the screw machine to compete with this process. The lead screw has been applied, as on the engine lathe, and the Fox chasing attachment has also been used to good advantage in many classes of work. The engine lathe scheme, however, employs a long screw which wears in one spot in the average run of work, and there are besides many joints, both sliding and rotary, between the spindle and the tool, and the lost motion in these joints results in a large thread at both ends of the screw. The Fox chasing apparatus is much more simple and effective in its operation for this work, and is much quicker in action as well, although its use is restricted to short threads. The weakness of the device, however, has confined its use almost wholly to the softer metals. The Jones & Lamson Machine Co., of Springfield, Vt., who make the attachment we are about to describe, applied the Fox chaser in the '80's and later in the 90's to their machines, but do not consider the arrangement stiff enough to control the tool properly.

The device illustrated in Figs. 1 to 4 is designed to obviate the difficulties of both the older arrangements. It may be

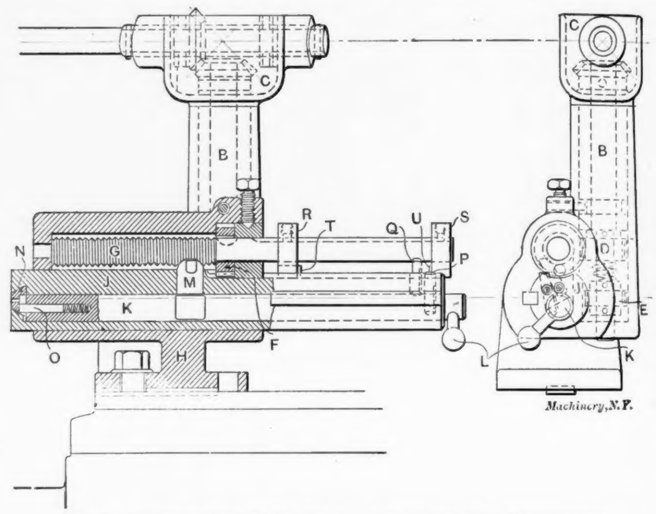


Fig. 1. Construction of the Mechanism of Chasing Attachment.

readily applied to any form of lathe, although at the present writing it is the intention of the builders to restrict its use to the Hartness flat turret lathe. Referring to the halftone, Fig. 2, and the line cut, Fig. 1, it will be seen that a horizontal shaft, A, connected by the spiral gearing shown to the spindle of the machine, drives the vertical shaft B of the device through the bevel gearing in case C. This vertical shaft carries a spiral gear at D and a spur gear at E. The spur gear is driven by the frictional pressure of two collars, maintained by the spring indicated by the dotted lines. The spiral gear D drives a mating gear F, keyed to the lead screw G, which thus revolves constantly in one direction. This lead screw is mounted in a holder H fastened to the flat turret; within this holder is the tool bar J which is keyed to prevent turning, but is free to move forward and back. The tool bar carries throughout its length a rod K which may be rocked by handle L. In the position shown for this handle, plug M, which serves as a nut for the lead screw, is raised into contact with it; and the tool N, which is dove-tailed to the face of the bar J, is moved forward into cutting position. If now handle L is raised, a flat on shaft K allows nut M to drop out of engagement with the lead screw; eccentric pin O, engaging a slot in tool N, withdraws it from the work, and the friction driven gear E, meshing with rack teeth on the further side of tool bar J, causes it to be rapidly withdrawn.

The alternate raising and lowering of handle L, required for the operation of the attachment, may be performed automatically by the device itself. Two plugs, P and Q, are pro-

vided; if P is depressed, handle L will be lowered, while if Q is depressed, handle L will be raised again. Stop collars R and S, on an extension of the lead screw, limit the travel of the tool and the length of the thread which may be cut. With the parts in the position shown, with the tool

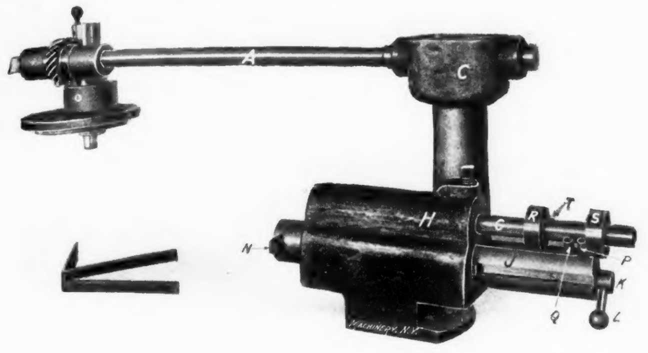


Fig. 2. Chasing Attachment for the Flat Turret Lathe.

advancing slowly forward on the cutting stroke under the action of lead screw G and nut M, the action continues until tappet Q approaches revolving collar R, when pin T, mounted in this collar strikes the top of Q, knocking it down, raising handle L and thus withdrawing tool N from the work, and nut M from engagement with the screw, by mechanism previously described. Friction-driven gear E is then able to withdraw the tool bar J, which action persists until tappet P strikes stop collar S, thus limiting the backward movement. Here the bar remains for a fraction of an instant until pin U in this collar strikes the top of tappet P, lowering handle L, moving the tool outward and throwing nut M into engagement with screw G, whereupon the cutting action again commences.

It will thus be seen that the cutting edge is advanced at the proper rate of speed for threading, withdrawn after the proper length of stroke has been taken, returned to its first position, again advanced to cutting depth, fed forward, and so on without attention on the part of the operator as long as the device is in use. The successive increases in depth of cut for each chip are made by advancing the cross

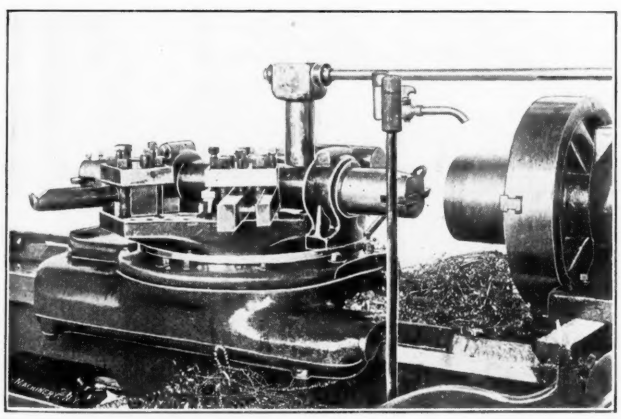


Fig 3. The Attachment in Position for Operation in Connection with a Boring Bar.

sliding head of the machine the amount required each time. In changing from one pitch to another, it is only necessary to replace screw G and nut M, an operation as easy as the changing of gears on a lathe. For cutting left hand threads, bracket C is reversed so as to drive spindle B in the opposite direction with relation to the spindle of the machine. Though either a single-threaded tool or one of chaser form such as shown in Fig. 2 may be used, in the latter case sufficient clearance must be provided to the side cutting edges to allow the lead screw to guide the tool without interference from the action of the work on the chaser. It will be noted that the constantly exerted pressure of friction gear E takes up all backlash in the mechanism itself, and that the turret slide is stationary throughout the operation, and may be even clamped to the bed. These two conditions are very favorable ones for the production of accurate threads.

Fig. 4 shows the apparatus mounted on the turret, and Fig. 3 shows it in action, although it is more or less obscured by the heavy boring tool mounted opposite it at the same station of the turret. When seen in operation as set up in this way, however, its movements are very interesting, the mechanism involved in its construction seeming ridiculously simple when compared with its complicated functions.

Fig. 4 incidentally gives a view of the swivel chuck jaws furnished with the flat turret lathe the action of which is very simple. It is well known that a four-jaw chuck generally tends to flatten slender work one way more than another, but even if it were possible to get an even pinch on each pair of jaws, there still remains the fact that there would be a tendency to squeeze the piece to a four-sided form. A three-jaw chuck gives equal distribution of pressure to each edge, but it has a still greater tendency to deform the work. By the use of the swivel jaws the equal pressure of the three-jaw construction is retained, but by dividing this pressure into six different points of application, the use of great holding power is permitted without appreciably distorting the work from its natural form.

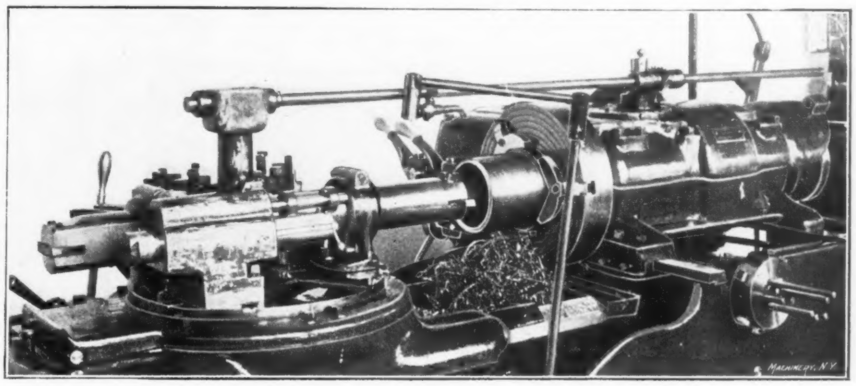


Fig. 4. The Attachment in Place on the Flat Turret.

The turret chasing tool just described is not part of the regular equipment of the flat turret lathe, but it may be added to any machine recently shipped. It cuts screws of any diameter from the 12 or 14 inch swing of the lathe, down to 2¼ inches in diameter for internal threads, and about 1 inch for external threads, of any length less than 5 inches. The holder may be swivelled for cutting taper threads, or may even be employed for taper turning to very good advantage.

A UNIVERSAL TOOL-MAKER'S VISE.

The Patterson Tool & Supply Co., of Dayton, Ohio, have lately undertaken the sale of the swivel vise shown in Figs. 1 and 2. It should prove to be a very handy device for toolmakers and machinists, since it may be used for a variety of

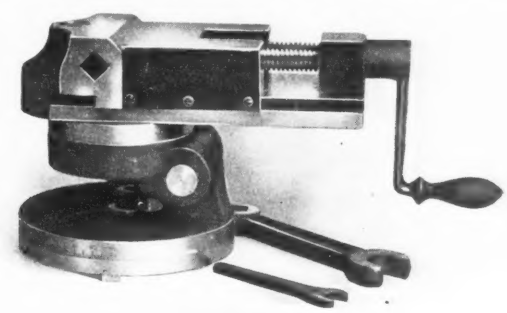


Fig. 1. Universal Vise in Horizontal Position.

operations that would otherwise be quite difficult. As may be seen, it consists of a base which is clamped to the table of the machine, an intermediate plate which can be clamped to the base at any angle in a horizontal plane, and a bracket ad-

justable in a vertical plane about a pivot attached to the intermediate plate; this bracket carries, in turn, a vise of simple construction. It is thus possible to present a piece of work to a cutting tool in the drill press, shaper, miller, or other machine, at any desired angle with relation to the rectangular surface by which it is held. The width of the jaw is 4 inches. The total height when in a horizontal position is 6 inches. The extreme capacity when the jaws are open is $3\frac{1}{8}$ inches; the diameter of the base is 6 inches and the weight is about 28 pounds.

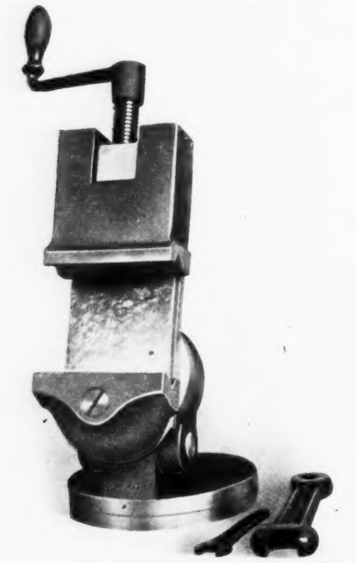
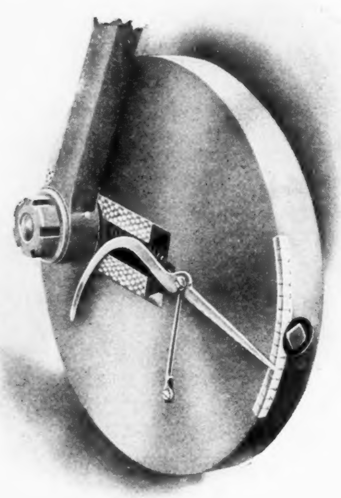


Fig. 2. Vise Set for Angular Cut.

A STROKE INDICATOR FOR THE SLOTTING MACHINE.

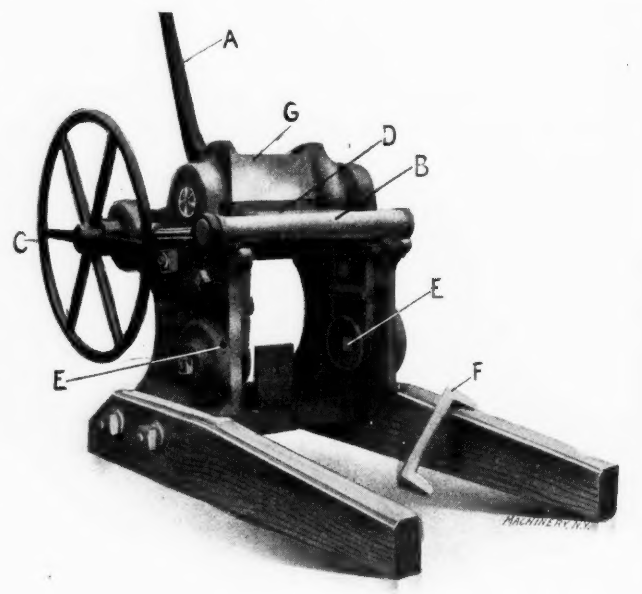
The T. C. Dill Machine Co., Philadelphia, Pa., have devised a stroke indicator for their slotters, which serves the same purpose as the graduated dials usually furnished with shapers for indicating the length of travel of the ram. As may be seen from the cut shown herewith, the device is extremely simple, consisting only of a pointer having a curved inner extension bearing against the adjustable crankpin of the crankshaft. The spring provided keeps it pressed against the pin as it is adjusted out and in. The shape of the curved portion of the lever is such that the outer end, or pointer, traveling on the scale shown, will indicate the length of the stroke on evenly spaced graduations. It is believed by the builders that this device will be appreciated by anyone familiar with the difficulty of setting a slotter by guess to the proper stroke. By the usual method of adjusting the machine, if the first guess is not right a second is made, and so on. The last guess may not be right but the time lost in changing to a more accurate setting would be almost as great, (so the operator imagines) as the time to be gained by changing the stroke, not to mention the extra exertion required; so the machine continues to go with perhaps a couple of inches more travel than is needed; whereas had the stroke been right, the machine might perhaps have been run at a faster rate, making more strokes per minute at the same cutting speed.



The Dill Slotter Stroke Indicator.

THE PENNOCK IRON BENDING MACHINE.

The American Road Machine Co., Kennett Square, Pa., have been building for some years an iron bending machine which has found extensive use in car shops, iron works, etc. Since it has only recently been introduced as a machine shop tool, a description of it may be interesting to our readers. There are two dies on the machine, the lower one of which is marked *B*. This is moved in a horizontal direction by means of hand wheel *C*. The material to be bent is inserted between the two jaws at *D* and by means of the hand wheel, the dies are made to clamp the material so that it is held in the position desired for bending. To accommodate varying thicknesses of stock the lower jaw can be moved in a vertical direction by means of eccentrics *E E* as shown. After the material has been clamped in place, lever *A* is moved downward, thus bringing the upper die marked *G* in contact with the material to be bent, drawing it down to the lower die, or, in case a different angle from that of the die is desired, bringing it down to a die block such as is shown at *F* in the cut. It will be seen that this is a very simple operation, though a surprising variety of irregular shapes may be produced. Its extreme capacity for thickness of stock is $1\frac{1}{2}$ inch. It will take a sheet of any width to 12 inches. Small iron is worked cold, while the heavier sections are heated.



The Pennock Iron Bending Machine.

* * *

The dream of the electrical engineer has been to burn coal at the mine's mouth and transmit the generated power by electricity to the users in towns and cities. The cost of long transmission lines and loss of efficiency have prevented such projects being carried out; practically all the longest transmission lines in existence are those operated by water power. It appears, however, that the dream of the electrical engineer is about to be realized. An electrical corporation has been chartered at Hazleton, Pa., for the purpose of manufacturing electricity and furnishing it for the purpose of light, heat and power to the counties of Luzerne, Columbia, Schuylkill, Berks, Lehigh, and Northumberland. A big power plant is to be erected at Harwood and the lines of wires will reach to Reading, Allentown, Sunbury, Mauch Chunk, Shamokin, Bloomsburg, and various towns and hamlets within a radius of 100 miles or so. The scheme is to burn the vast piles of culm and rice coal that have accumulated during the last fifty years. The rice coal is a very low grade of fuel, containing a large percentage of slate, and is profitable to use only where it can be burned without rail transportation. It is possible that this scheme is only the beginning of a much larger scheme which will ultimately transmit power to the larger cities like Philadelphia, New York, Baltimore, and others within a few hundred miles of the hard coal regions.

EUROPEAN INDUSTRIAL NOTES.

TENDENCIES IN BRITISH MACHINE TOOL DESIGN.

The year 1906 has been one of almost unexampled activity in the British engineering trades, and probably no branch has been more heavily engaged than that devoted to the manufacture of machine tools. Several advances in wages have to be recorded, but one of the most serious disputes—the strike for a wage advance of iron shipbuilders and boilermakers on the Clyde—ended in the return of the strikers to work without any concession being obtained. The strike was not well timed, the "boom" in shipbuilding having then declined for the time being, and consequently the employers were comparatively little inconvenienced. As previously mentioned, specialization in tool building is becoming decidedly more marked than in the past, though the tendency is still characteristically modified by due regard of caution.

A number of makers are specializing on high-speed, or perhaps more correctly, high-power, lathes, while many others build such tools to order or in smaller lots than the first-named. Langs, of Johnstone, Scotland, have gone about the most largely into mass production cf lathes which, in addition to high power, embody very complete arrangements for automatically varying the cutting speed in accordance with the diameter of the work being dealt with. Others, by special design of headstock and fine gradation of speeds, bring the cone drive about up to its limit of efficiency. Constant-speed belt and "all-gear" drive forms the special feature in the leading lines of other builders. In many cases more or less well-founded claims are made on account of improved design of the beds and tailstocks, as also quick change arrangements of feeds and devices for preventing sliding and screw-cutting feeds being engaged simultaneously. Motor-driven headstocks are becoming more often on offer, and the stiff proportions of tailstocks, their correct alignment and secure clamping are points on which special stress is laid by several concerns, one of which uses ratchet teeth on the under side of the shears into which corresponding teeth on the clamp plates engage. Taken altogether, the tool builders would appear to have easily overhauled the tool steel makers' products, so the next move will lie with the steel makers.

High-speed planing, of course, presents its own problems, which are being tackled with decidedly encouraging results by toolmakers generally, and by a few specialists devoting themselves solely or principally to their commercially successful solution. The Bateman's Machine Tool Co., Ltd., Leeds, specialize on the light and moderately heavy classes of machines adapted for quick cutting with depths and widths of cuts likely to be required by general users. The racks under the tables, controlled by suitable springs, have—before acting integrally with the table—sufficient longitudinal motion to absorb the momentum of the moving table and work, and, within fine limits, reverse, without shock. (For description with cut see MACHINERY, July, 1905.) From the latest data issued by the company, the following may be taken as typical performances on regular machines:

	Forward Stroke.	Return Stroke.	
24 in. x 24 in. x 6 ft....	78 ft.	210 ft.	
36 in. x 36 in. x 20 ft....	23 ft.	150 ft.	3-speed gear box.
36 in. x 36 in. x 20 ft....	41½ ft.	150 ft.	3-speed gear box.
36 in. x 36 in. x 20 ft....	60½ ft.	150 ft.	3-speed gear box.
42 in. x 42 in. x 14 ft....	48 ft.	147 ft.	
42 in. x 42 in. x 12 ft....	57½ ft.	165 ft.	
48 in. x 48 in. x 8 ft....	51½ ft.	150 ft.	
60 in. x 60 in. x 12 ft....	25 ft.	144 ft.	3-speed gear box.
60 in. x 60 in. x 12 ft....	42 ft.	144 ft.	3-speed gear box.
60 in. x 60 in. x 12 ft....	60 ft.	144 ft.	3-speed gear box.

Thos. Shanks & Co., Johnstone, pay special attention to planers designed with a view to decidedly heavy cutting with such measure of high-speed forward and return strokes as the customer is disposed to provide the requisite power for. Messrs. Shanks now make the beds 1¼ times the length of stroke as against the usual even lengths. The speeds here given are for machines weighing from 5 or 6 tons on the 2½-foot sizes to 100 tons on the 12-foot sizes—2,240 pounds to the ton.

These speeds are permissible when taking four heavy cuts with tools on cross slide, with power to spare for two side tools also cutting.

	B ft.	C ft.	D ft.	E ft.
B = minimum width and	2½	70	20	34
depth capacity of	3½	65	19	32
strongest type.	4½	60	18	30
C = maximum return stroke	5½	55	17	28
speed.	6½	50	16	26
D = slowest cutting speed	7½	45	15	24
for hard metal.	8½	40	14	22
E = highest cutting speed	10	35	13	20
for medium metal.	12	30	12	18

The Mitchell's Reversing Gear Syndicate are introducing a patented device for use in connection with new or existing machines. The peculiar feature of this method is the employment of two heavy flywheels, the momentum of which is transmitted through wide belts at the reversals of the table. By means of gearing the flywheels revolve in opposite directions, at speeds proportionate to the ratio between the speeds of the forward and return strokes.

The wide belts on the flywheels are loose, and are alternately pressed on to the lightly constructed driving pulleys by idler or "jockey" pulleys. Frictional clutches are embodied in the flywheels and are adjusted to such a load as can safely be negotiated by the toothed gearing, the clutches slipping immediately the predetermined duty is exceeded. The cutting and return speeds favored by the Mitchell company approximate to those first mentioned. Alfred Herbert, Ltd., Coventry, were one of the first British firms to manufacture a limited number of types of machine tools in quantity. Turret lathes of fully and semi-automatic types are perhaps the leading line, but the manufacture of milling machines of horizontal and vertical types of the most modern design now form an important branch of the company's business. The success of the firm's policy of giving the fullest consideration to American ideas of methods and designs while at the same time keeping European requirements and conditions in view has been most marked. The hexagonal design of lathe turret is one of their distinctive models which has been appreciated the world over and is applied to a wide range of machines for bar and chucking work. The equipment of the works has, from its inception, included the best known types of tools for repetitive and general work, the toolroom, casting, stores, and other auxiliary systems being organized on corresponding lines. The shop methods are constantly under review with the object of attaining all possible efficiency by taking advantage at the psychological moment of the changes always in progress in the relative merits of, say, milling, planing, grinding, etc. Jigs of the most progressive build have been consistently employed all along, to a degree, and in sizes which were at one time quite exceptional in British practice. All the present models of tools built by the company are designed on lines which admit of utilizing the new alloy steels to the limits which the work being dealt with will admit of. We may add that a new branch works, entirely self-contained as regards equipment is now in process of erection. (Some details of these works will appear later.) Perhaps we may add that a feature too often neglected by otherwise competent concerns, has received appropriate attention from the firm, *i. e.*, the training of a body of competent operators, instructors, and salesmen, a policy which has probably played a far from negligible part in the building up and consolidation of this interesting industrial entity.

JAMES VOSE.

Manchester, Eng., December 29, 1906.

MISCELLANEOUS FOREIGN NOTES.

ALFRED HERBERT, LTD., Coventry, England, are constructing a new shop for building machine tools, as the present prosperous state of the machine tool business in Great Britain has proven their present facilities to be inadequate for the growing demand for their products.

WM. ASQUITH, LTD., Halifax, England., have brought out a new high-speed radial drill. This machine is particularly rigid. The arm can be swung through an arc of 150 degrees, 90 degrees to the front and 60 degrees back. The drill is motor-driven and has eight changes of feed. The maximum height under the spindle is 7 feet 3 inches. The base plate is 7 feet long by 6 feet wide.

DRON & LAWSON, LTD., Glasgow, Scotland, have designed and placed on the market a new bolt cutter, with dies so designed that parallel and taper threads can be cut by the same dies. The internal diameter of the spindle is 7 inches. The machine is motor-driven, the range of the revolutions per minute of the spindle is from 4 to 31, all speed changes being made without stopping the machine.

MACHINES FOR THE MAKING OF WIRE NETTING IN VICTORIA.—Consul-General J. P. Bray, of Melbourne, reports that the government of Victoria has accepted a local bid for the supply of eight machines at the price of $5,000 for the manufacture of wire netting. These machines are for the purpose of establishing the industry in the penitentiary at Melbourne and supplying prison-made wire netting to landowners at cost price on long terms of repayment to enable them to cope with the rabbit pest.

THE VIEW OF GERMAN COURTS REGARDING OWNERSHIP OF MACHINERY IN FACTORIES.—Consular reports from Germany state that the imperial court has lately in a number of cases held that machinery when installed in a factory or manufacturing plant becomes a fixture, and that therefore a sale upon condition that the title remain in the seller until the machinery is paid for must give way, in case of the bankruptcy of the buyer to the rights of his creditors, and the machinery becomes part of the assets of the bankrupt. The rights of the holders of mortgages on the plant therefore have precedence over the rights of the seller of the machinery, no matter on what terms the sale was made. German manufacturers of machinery are strongly protesting against this decision by the court, calling attention to the fact that this ruling is unjust, the mortgagee receiving rights and security upon which he did not rely when he loaned his money, while the seller of the machinery is deprived of rights for which he expressly contracted, and relying on which he sold the goods and gave the buyer credit. It is claimed that this ruling of the court will greatly impede industrial progress, in that it will greatly limit the credit given by manufacturers and dealers in machinery to capable men who are short of capital and need assistance in the shape of credit in establishing new plants or enlarging those already established. Manufacturers and dealers in machinery who deal with German customers should therefore be very careful about the credit of their prospective customers and should not rely entirely upon the conditions of their contract of sale.

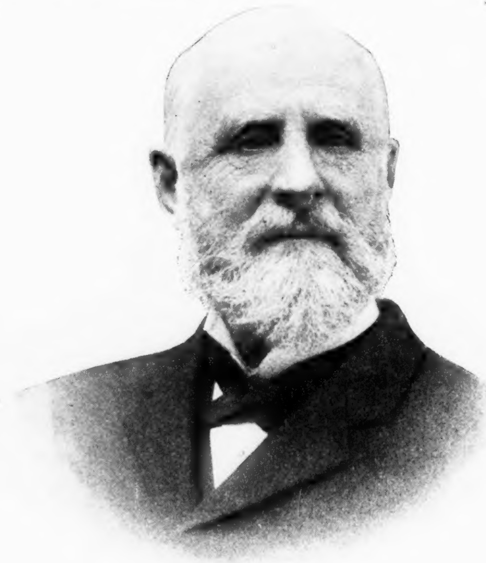
* * *

OBITUARY.

Edward Payson Bullard was born August 18, 1841, in Uxbridge, Massachusetts. After the completion of his apprenticeship in the machinist's trade at the Whitin Machine Works, Whitinsville, Mass., he went to work at the Colts Armory in Hartford, Conn., where he remained until the latter part of 1863. He then entered the employ of Pratt & Whitney working as a machinist until April, 1865. At this time he formed the partnership of Bullard & Prest, carrying on a general machinists' business in the old County Jail Building, Hartford, on which site the Case, Lockwood & Brainard Co. is now located.

In March, 1865, Mr. William Parsons was admitted to the partnership and the name changed to Bullard, Prest & Parsons; Mr. Prest withdrew early in 1866 and the firm became Bullard & Parsons. Vertical drill presses (one of which is now in use at the Bullard works) and pumps were the chief products of the firm. With the idea of moving the business to Norwalk, Conn., Mr. Bullard, in September, 1866, went to that city and interested a number of men in the project, the Norwalk Iron Works Co. being organized for that purpose on October 5, 1866, with Mr. Bullard and Mr. Parsons as members of the board of directors. Changes in the plans were subsequently made, Messrs. Bullard and Parsons withdrawing and continuing their business at Hartford.

The depression of 1868 and lack of capital forced the firm into bankruptcy in August, 1868. A reorganization was effected and, removing to Bristol, Conn., Gray's Foundry (established some years previously by Elisha N. Welch, later more famously known as a great clock-maker) now the site of the Sessions Foundry Company, was purchased by them and operated for a period of one year when the firm dissolved and Mr. Bullard secured the position of superintendent in a large machine shop at Athens, Georgia. The bitter feeling against all Northerners was then at its height and on that account Mr. Bullard resigned his position and went to Cincinnati, Ohio, where he soon became known as a dealer in second-hand machinery. His first sale was of a large number of Lincoln milling machines which he had found in an abandoned Confederate arsenal in Georgia. He then connected himself with the Cincinnati branch of Post & Company, organizing their machine tool department, which has since become the E. A. Kinsey & Co.



Edward Payson Bullard.

Early in 1872 he went to Columbus, Ohio, to assume the position of general superintendent of the Gill Car Works in that city, leaving there in 1874 when the plant was closed down as a result of the panic of 1873. For a short time in 1874 he was superintendent of the Cooper Engine Works at Mt. Vernon, Ohio. Leaving there he established himself in the machinery business on Beekman Street, New York City, in 1875, organizing Allis, Bullard & Company at 14 Dey Street one year later. Mr. Allis withdrew in 1877 and the Bullard Machine Co. was organized, continuing the business at the same address until 1880, when Mr. Bullard secured entire control and continued as E. P. Bullard, dealer.

Recognizing the demand for a high grade lathe, in 1880 he went to Bridgeport, Conn., and engaged Mr. A. D. Laws to manufacture lathes of his design, he agreeing to take the entire output of the plant. Owing to certain unsatisfactory features of the arrangement, Mr. Bullard, in the latter part of the same year, took over the business and styled it The Bridgeport Machine Tool Works, he being the sole owner. In 1883 he designed his first vertical boring and turning mill—a single head, belt feed machine having a capacity of 37 inches, which was later sold to George A. Young, a manufacturer of paint-making machinery in Brooklyn, N. Y. This is believed to be the first machine of this type having such small capacity; boring and turning work of this size having been done in the faceplate of a lathe.

In 1889 business in Bridgeport had increased to such an extent that he discontinued his New York connections and devoted his entire time to the development of the Bridgeport plant; Mr. J. J. McCabe, a member of Mr. Bullard's New York staff, established himself in the old warerooms. The Bridgeport Machine Tool Works was incorporated in 1894 under the name of The Bullard Machine Tool Co., the ownership of stock being entirely in the hands of Mr. Bullard and his sons. Under this name the business is still being carried on.

Mr. Bullard died suddenly December 22 at Braidentown, Florida, where he had gone a few days previously for his regular winter sojourn.

PERSONAL.

C. H. Rhodes, formerly manager of the Grand Rapids branch office of McDonnell, Stocker & Co., Chicago, has been made sales manager of the Wilmarth & Morman Co.

R. H. Mitchell has resigned from the Olds Motor Works to accept the position of superintendent of the machine department of the Kansas City Motor Car Co.

E. T. Gorham, for over seven years superintendent of the Oliver Machinery Co., Grand Rapids, Mich., became a stockholder and director of the Wilmarth & Morman Co., January 1, and will fill the position of shop manager.

Asa M. Mattice has announced the discontinuance of his business as consulting engineer with offices in New York City and his assumption of the management of the works of the Walworth Mfg. Co., South Boston, Mass., beginning January 1, 1907.

Edwin W. Beardsley, formerly chief draftsman of the Rockwell Engineering Company, New York, more recently of Waterbury, Conn., has taken charge of the building division in the engineering department of the American Brass Co., of Waterbury, who operate a number of brass mills in the Naugatuck Valley.

William J. Clark, of New York, was appointed delegate from New York State by Governor Hughes to attend the national convention for the extension of foreign commerce of the United States which was held at Washington, D. C., January 14, 1907. Mr. Clark is general manager of the foreign department of the General Electric Co. and for many years has been interested in the conditions of foreign commerce.

H. J. Lamborn has been appointed superintendent of the power and plant of the Yale & Towne works, Stamford, Conn. The position is a responsible one, involving, as it does, the management of all the steam and electrical apparatus, the supervision and designing of new buildings, and in general everything relating to steam and electric power and distribution, heating, ventilation, water supply, drainage, fire department, up-keep of buildings and general repairs.

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FRESH FROM THE PRESS.

THE ENGINEERING QUARTERLY OF THE UNIVERSITY OF MISSOURI. 80 pages 6½ x 9¾ inches. Published four times during the scholastic year by the Engineering Society of the University of Missouri, Columbus, Mo. Price, $1.00 per year.

The first issue of the Engineering Quarterly contains among other articles one on Electric Drive, by Prof. H. B. Shaw; the Steam Turbine with Superheated Steam, by E. A. Fessenden and J. R. Wharton; Test of Reinforced Concrete Beams, by W. K. Seitz; Note on the Allowance of Decreased Efficiency by Prof. Arthur M. Green, Jr., etc.

STEEL SQUARE POCKETBOOK. By Dwight L. Stoddard. 159 pages, 3¼ x 5 inches. 150 cuts. Published by the Industrial Publication Co., New York. Price, 50 cents.

This is one of several treatises on the use of carpenters' steel squares, and of course is of more technical interest to carpenters than any other class of mechanics. It is an interesting work to look through and see the multitudinous use to which the ordinary carpenters' tool can be put and the surprising problems that can be solved in a moment's time by its application. To the student of geometry the use of the steel square is of almost fascinating interest. The work is of strictly practical value and is one that can be recommended for the class of mechanics to whom it will appeal, that is, carpenters and builders.

MACHINE DESIGN. By Prof. C. H. Benjamin. 202 pages, 5 x 7½ inches, published by Henry Holt & Co., New York. Price $2.00.

This work is based on "Notes on Machine Design" published by the author in 1895. The original notes have been entirely rewritten and the mathematical work revised and considerable new matter has been added, much of which represents the author's experience in his direction of the laboratory work of the Case School of Applied Science, Cleveland, Ohio. We know of no work on machine design which can be more heartily recommended to the average student than this. The author has aimed to present "what the student needs to learn before graduation, as this is what he needs to remember afterwards." In other words, he has presented the essentials, leaving off the frills with which too many works on machine design are "ornamented." The work has the characteristics of Prof. Benjamin's writing in general: that is, clearness and simplicity. It is brought up to date, containing, for example, a summary of the paper on the collapsing strength of lap-welded steel tubes presented by Prof. Stewart before the spring meeting of the A. S. M. E., 1906. The matter on the bursting strength of cast-iron cylinders is particularly valuable. A running review of the chapters will give an idea of the contents. These are in order: Units and Tables; Frame Design; Cylinders and Pipes; Fastenings; Springs; Sliding Bearings; Journals, Pivots and Bearings; Ball and Roller Bearings; Shafting Couplings and Hangers; Gears, Pulleys and Cranks; Fly-Wheels; Transmission by Belts and Ropes.

SELF-PROPELLED VEHICLES. By Prof. J. E. Homans. 598 pages, 5½ x 8½ inches. 399 cuts. Published by Theo. Audel & Co., New York City. Price, $2.00.

This is the fifth edition of a popular work on the automobile, which has been revised and partly rewritten. As is consistent with the present development of the automobile, by far the greater part of the work is given up to a consideration of the characteristics of the gasoline vehicle. A valuable feature is three double-page diagrams showing side sectional elevation of an American four-cylinder touring car; the plan of an American gasoline vehicle showing the engine and operative mechanism (being a half-tone view looking down upon the chassis); and the third diagram is of the cranks and cycles of multiple cylinders showing the relation of 2-cylinder, 3-cylinder, 4-cylinder and 6-cylinder cranks, together with their working strokes. The book as a whole is well gotten up, copiously illustrated, clearly written and is just the kind of a work that will appeal to thousands of people interested in the mechanical features of the automobile either as users, prospective users, or mechanics. About the only criticism to be offered is that some of the cuts are not strictly first class in execution, but all of them are clear enough to be easily understood and this, of course, is the principal consideration in a low-priced book. Enough space is given to theoretical treatment of principles of the gasoline motor to satisfy the amateur theorist. Considerable space is given to the electric systems used for ignition. The bulk of the work is strictly practical and, as intimated, it contains a large amount of practical information on the subject.

ELECTRICAL ENGINEERING. By E. Rosenberg, translated from the German by W. Haldane Gee and Carl Kinzbrunner. 360 pages, 6 x 9 inches. 333 cuts. Price, $2.00 net.

This work is intended to be an elementary textbook, suitable for persons employed in mechanical and electrical engineering trades and for elementary students of electrical engineering, etc. It had its origin in a series of lectures delivered by the author some years ago to the workmen and staff of a large German manufacturing concern. The work, therefore, deals with fundamental principles and describes in common language various electrical apparatuses and the principles governing them. It begins with a dissertation on electric phenomena, explaining electromotive force, magnetism, electric units, electric measuring devices, electromagnets, etc. Chapter III. takes up the continuous-current dynamos, beginning with the ring armature, and describes the various types of continuous-current machines. It also gives considerable space to the faults and troubles likely to be met with in generator and motor operations. It describes motors used for various mechanical purposes, *i. e.*, machine tool driving, cranes, hoisting, electric traction etc. Accumulators receive attention, various types being described and illustrated, and a chapter is given on electric lighting. Chapter VIII. is on alternating currents, giving a good elementary treatment of the subject, following which is a chapter on alternators, measuring instruments used with alternating currents, converters, commutator motors, induction motors, etc. The work is undoubtedly one that contains a great deal of valuable information for the non-technical man, whether he be a student, mechanic, railway man, or other worker.

THE ENGINEERING INDEX. Volume IV., 1901-1905 inclusive. Edited by H. H. Suplee and J. H. Cuntz, with Chas. B. Going. 1234 pages 6½ x 9½ inches. Published by the *Engineering Magazine*, New York. Price, $7.50.

This work aims to be an index of articles of permanent value that have appeared in the world's engineering publications, and to give a brief succinct description of each article, stating number of words, cuts, author, name of publication, date, etc., in the least possible number of words. The list includes about 260 weekly, semi-weekly, monthly, semi-monthly, quarterly and yearly publications which are regularly reviewed. The work contains approximately 35,000 subjects, indexed and classified with the idea of making it easy, for a user who has in mind a definite item or article, to locate it. It is also prepared so far as possible to meet the convenience of users who are investigating a certain subject and desire to be informed on all the articles that have been published pertaining to that subject. The work is uniform with the previous engineering indexes that have been published, these being Vols. I., II. and III., beginning with 1884. The succeeding volumes will be published annually. The work is a rearranged compilation of the regular monthly index found in the *Engineering Magazine*, already well known to many of our readers. It is a work to be highly commended, for with the enormous multiplication of subjects and great extent of technical literature at the present time it is almost hopeless for any engineer to keep in touch with all matter pertaining to his business, which is published in the world's technical literature, especially if he is remote from the large centers. The Engineering Index will be to him a time-saver and, therefore, a life-saver, if he would keep in intimate touch with the literature concerning his profession. Needless to say it is indispensable for engineering libraries.

POCKETBOOK OF MECHANICAL ENGINEERING. By Charles M. Sames. 203 pages, 4 x 6½ inches (regulation pocketbook size page), and 40 figure numbers. Bound in flexible leather. Published by the author, Jersey City, N. J. Price $2.00.

This work is a pocketbook that is a pocketbook, *i. e.*, one that can be carried comfortably on the person. It is no reflection on their general excellence to say that most of the other so-called "pocketbooks" are so by courtesy only; their Falstaffian proportions quite prohibit convenient transportation, save it might be in a handbag. The book in review is the second edition of what is probably the most meaty book of its size ever published on the subject of mechanical engineering. While containing less than 200 pages of actual matter (excluding index) it actually contains the gist of several large volumes as usually presented. In fact, it would be difficult to select a half dozen mechanical works (excluding other pocketbooks) which would contain all the essential matter found therein. The matter is set in 6-point with narrow margins and is boiled down to almost the last degree of concentration. The new edition contains additional matter on strength of materials, energy and transmission of power, heat and heat engines, hydraulics and hydraulic machinery, shop data, electrotechnics, etc. The same subjects are treated at length in the body of the work, which also includes chapters on mathematics and materials. Two pages are devoted to an explanation of symbols and abbreviations used in the text; this feature could very profitably have included other symbols even though they were not used in the work, as, for example, the complete Greek alphabet, both capitals and small letters, and this criticism applies to handbooks in general. Few engineers are Greek scholars and they are often embarrassed in reading formulas to give the names of some of the Greek letter symbols occasionally used. This is not of so much consequence, however, as that of establishing in general use standard symbols which shall have certain definite meanings, and that is just what the handbooks can greatly help to do.

NEW TRADE LITERATURE.

J. W. KERR CO., 43 West Washington St., Chicago, Ill. Pamphlet giving dimensions and prices of machinists', electricians' and woodworkers' tools.

THE CROCKER-WHEELER CO., Ampere, N. J., have sent us a 1907 calendar, printed in colors, showing a view of the main office and works of the company's plant at Ampere.

THE SMITH COUNTERSHAFT CO., Boston, Mass. Catalogue illustrating and describing the one-belt reversing countershaft and pointing out some of the advantages obtained by its use.

SPRAGUE ELECTRIC CO., 527 West Thirty-fourth Street, New York City. Flyer No. 225 showing a few of their many combinations of hoists, carriages and cranes. Pamphlet describing and illustrating the electric equipment of a modern hotel.

CONTENTS FOR FEBRUARY.

Patterson, Gottfried & Hunter, Ltd., 146 Centre St., New York City. Catalogue No. 77 for dealers and jobbers, illustrating and describing the various products of machinery and hardware which they have for sale.

The Waltham Watch Tool Co., Springfield, Mass. Pamphlet giving specifications for their new No. 0 Van Norman "Duplex" milling machine and describing profiling device and index centers for use with this machine.

Wm. Dawson & Sons, Ltd., "Cannon House," Bream's Buildings, London, England, have issued a directory for 1907 of English and Foreign newspapers, magazines, etc., together with foreign and domestic subscription rates for same.

Jenkins Bros., New York. Catalogue for 1907 on Valves and Packing. Description of their product, including dimensions and prices, is given. The constant increase in steam pressures has made necessary an increase in the manufacture of valves for extreme pressures, some of which are described herein.

The Davis Sewing Machine Co., Dayton, Ohio. Catalogue of the Davis screw-slotting machine. This machine is semi-automatic, requiring only a boy or girl to feed the screws; it will slot about 18,000 screws in ten hours. It can be fitted up to slot any number of kinds of screws and sizes of heads up to ½-inch diameter.

Reinforced Brazing and Machine Co., 1109 Arrott Building, Pittsburg, Pa., have issued a pamphlet entitled "Don't Throw Away Your Broken Castings," telling of the new Richardson method by which iron castings may be reinforced and brazed so that the tensile strength will be made even greater than it was originally. Letters from various firms testifying to the excellence of the work done by this method are included.

Ward-Leonard Electric Co., Bronxville, N. Y. Catalogue showing the various applications of the Ward-Leonard rheostats, circuit breakers and resistance units. Some of these have been installed in the Weston Electrical Instrument Co. of Newark, and in the plant of the Lanston Monotype Machine Co. for use with their casting machines. Crocker-Wheeler Co., Niles Tool Works, Northern Electric Mfg. Co. and many other well-known firms are using this electric apparatus in connection with their machines.

The American Locomotive Co., 111 Broadway, New York City, have recently published the fifth of a series of pamphlets on locomotives. This pamphlet is devoted to ten-wheel-type locomotives weighing less than 150,000 pounds, and will be followed shortly by another showing the heavier designs of this type. The pamphlet illustrates and describes 21 different designs of ten-wheel locomotives ranging in weight from 64,000 to 150,000 pounds and adapted to a variety of road and surface conditions. The series now includes pamphlets on the Atlantic, Pacific, consolidation and ten-wheel types, and copies of these may be had upon request.

Ingersoll-Rand Co., 11 Broadway, New York. Catalogue No. 91 describing the Davis "calyx diamondless" core drill. The drill is well described by its title. It is a prospecting drill producing cores from 1⅝ to 15 inches in diameter from any depth to 6,000 feet. It does not use diamonds, but has never found a material which it could not cut at a paying rate. The cost of the entire apparatus is often less than that of the diamonds alone where they are employed, and the cost of diamond maintenance and replacement is entirely eliminated. It gives a double record, depositing the cuttings successively as they occur and removing the core in convenient lengths. For ordinary materials a rotating toothed steel cutter is used, this having a chattering action instead of a smooth cut, and for the harder materials chilled steel shot are used as an abrading material the action of which nothing can resist. The apparatus is built in different sizes, the smallest operated by hand and the largest requiring 20 or more horsepower and capable of removing cores of large diameter from a great depth. The company have also issued a pamphlet, Form 45A, describing the operation of their various rock drills.

MANUFACTURERS' NOTES.

On and after January 1, 1907, the American Society of Mechanical Engineers will be located in the new United Engineering Societies Building, 29 West 39th St., New York City.

The Warner & Swasey Co., Cleveland, O. have opened a New York office at 149 Broadway (Singer Building), Room 521. Mr. H. L. Kinsley is in charge.

The Cleveland Crane & Car Co., Wickliffe, Ohio, recently received an order from the Empire Bridge Co., of Pittsburg, Pa., for the entire crane equipment of the Elmira, N. Y., bridge plant.

Messrs. Vaghi, Accornero & Co., machinery dealers in Milan, Italy, have removed their offices and show rooms to Corso Porta Nuova 34, where they have secured additional facilities and room required for their increasing business.

E. P. Dutton & Co., 31 W. 23d St., New York, have made arrangements with Archibald, Constable & Co., London, England, for the American rights of Prof. C. H. Benjamin's new book, "Modern American Machine Tools." This book was briefly reviewed in the January issue.

The Miami Valley Machine Tool Co., Dayton, Ohio, was incorporated in January, and will manufacture the "Miami Valley Lathe" and 12- and 14-inch sensitive drill presses. The incorporators are S. D. Conover, president; W. D. Foster, vice-president; P. P. H. Conover, secretary, and H. T. Chamberlain and E. R. Evinger.

The Niles-Bement-Pond Co., Trinity Building, 111 Broadway, New York, have appointed Messrs. Harron, Rickard & McCone, 436 Market St., San Francisco, Cal., agents for their entire line of machine tools, hammers, hydraulic machinery and electric traveling cranes for the states of California, Nevada and Arizona.

The Abrasive Material Co., Philadelphia, Pa., are shipping wheels to all parts of the world, one of their latest orders amounting to between seven and eight hundred wheels of various sizes, total weight of which was between four and five tons. In addition to this, shipments have been made to England, Germany, Austria, Japan and Siberia.

The Western Electric Co., Hawthorne, Ill., exhibited at the Electrical Show at Chicago, Ill., in January a large water color painting of their plant at Hawthorne, as well as samples of their product, such as American transformers, Thomas high-tension insulators, electro-insulating material, Western Electric Co.'s arc lamps, etc. Special features of their exhibition were an indestructible field coil for railway motors and a new induction motor.

The Lumen Bearing Co., Buffalo, N. Y., have established a Canadian branch at Toronto Junction under the management of Mr. N. K. B. Patch. It is a modern plant equipped especially for foundry work, with a capacity for 7,000 pounds of castings a day. It has the necessary crane equipment, etc., for handling castings up to 3,000 pounds. The company will continue to make its well-known "Lumen" bronze, as well as manganese bronze, brass and aluminum castings.

The Yale & Towne Mfg. Co., Stamford, Conn., in December announced to their superintendents and foremen, through Mr. Henry R. Towne, president, an increase of wages and piece rates to its employes which number over 3,000. Each individual rate will be reviewed and where necessary will be adjusted, due allowance being made for previous advances which have already been made since December 1, 1905. The proposed advances, with those already made, will make a total of about $120,000 per year to be distributed among the employes by changes in day rates and piece rates.

J. E. Snyder & Son, Worcester, Mass., well-known manufacturers of upright drills, are building a new shop 90 x 170 feet on the corner of Dewey and Parker Streets. It is of cement construction, rock face, one story high, with coal sheds, etc., additional, and gives a total floor space of 24,000 square feet—a little more than three times what is available in their present quarters. A number of new tools have been ordered and the shop will be equipped with traveling cranes and other labor and time saving appliances. The firm expect to be in their new quarters next May.

The Barriett Electric Mfg. Co., Cincinnati, Ohio, who have been manufacturing direct-current motors and generators for several years, have now started to manufacture a full line of alternating-current induction motors and have sent the first shipment of these to Mexico. During the past year the company have designed six new machines and have increased their output considerably. The Barriett motors can be bought in all large cities from New York to San Francisco, and have a wide range of usefulness, but are made especially for factory service.

The Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., have for the past year or so been making a specialty of casting open-hearth steel pipe castings suitable for high-pressure superheated steam. They have designed and built what they call a special tri-facing machine to facilitate the production of this class of work. This machine is capable of boring, facing and truing up a T or L fitting in one operation without in any way disturbing the original setting of the casting. It is said to increase the finishing capacity 200 per cent. The weight of the machine is about 50,000 pounds and it is equipped with a 30-horsepower motor to drive the three heads. It has a capacity for handling fittings of from 6 inches to 30 inches in diameter. The company will build another addition to their present power plant and orders have been placed for a 100-horsepower Harrisburg engine, one 300-K.W. Westinghouse generator and two 250-horsepower boilers.

The Technical Publicity Association devoted its meeting of December 20, at the Aldine Association rooms, 111 Fifth Ave., New York, to the subject of "The Value of Circulars and Printed Matter." Mr. Frank Vreeland, art editor of the American Printer spoke of the commercial value of beauty in typography, and Walter Gilliss, president of the Gilliss Press, New York, made some remarks about limited editions. The companies represented at the dinner by members of the association—which is confined to those connected with the advertising departments of machinery manufacturing industries—were as follows: Ingersoll-Rand Co., T. R. Almond Mfg. Co., Pope Mfg. Co., H. W. Johns-Manville Co., Yale & Towne Mfg. Co., John A. Roebling's Sons Co., American Locomotive Co., General Electric Co., Patterson, Gottfried & Hunter, New York Edison Co., M. H. Treadwell Co., Crocker-Wheeler Co., A. S. Cameron Steam Pump Works, and Lidgerwood Mfg. Co.

Hill, Clarke & Co., Inc., 156 Oliver St., Boston, Mass., have just rearranged their office and showrooms, which adds greatly to their